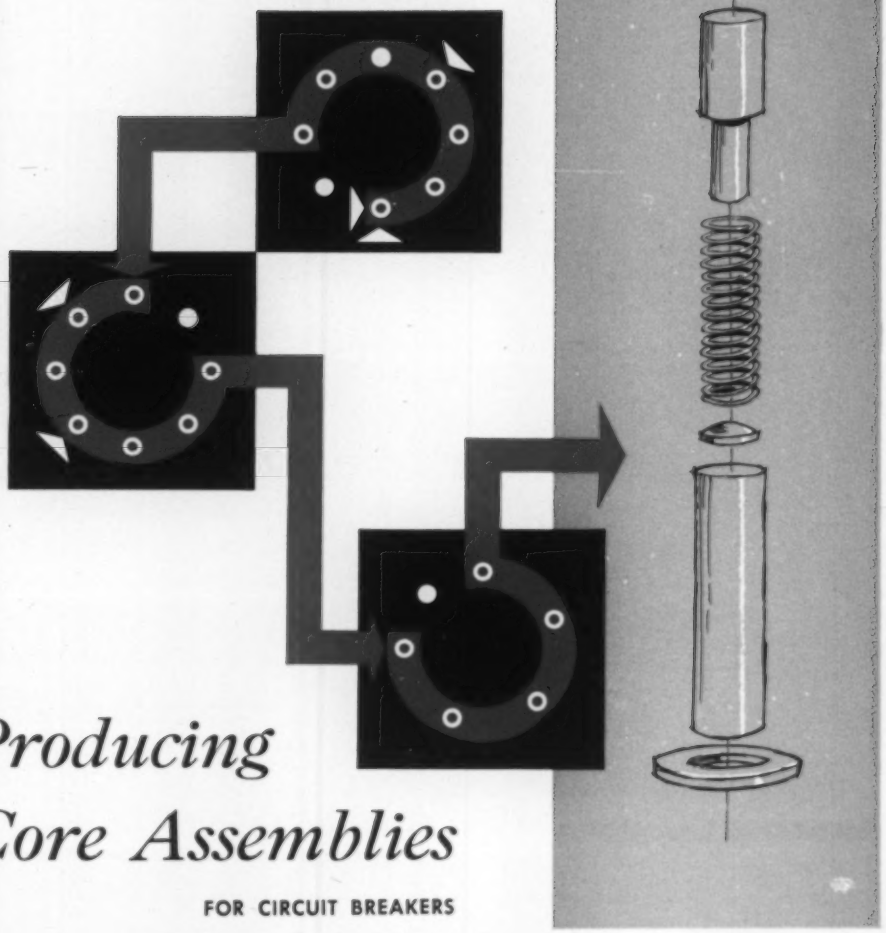
AUTOMATION

OCTOBER 1958



Producing Core Assemblies

FOR CIRCUIT BREAKERS

The Magazine of Automatic Operations

- Manufacturing Engineering
- Bulk Granule Handling
- Numerically Controlled Jig Boring
- Control of Machine Masses

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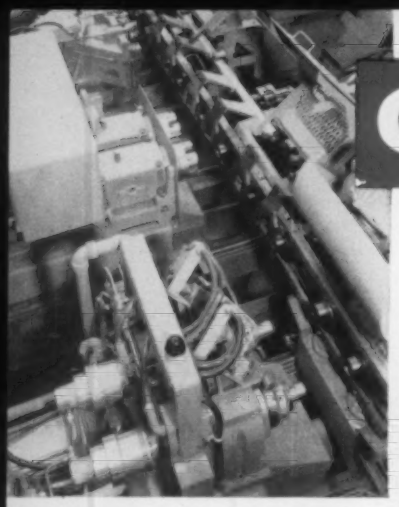
A PENTON PUBLICATION



Q Where does Heald automation BEGIN

... and where does it END?

A *Wherever you want— from rough casting to finished part!*

THE EXTENT to which you apply automation in your plant is largely a matter of production economics. But whether your automated lineup consists of two stations or twenty, Heald can do the whole job from start to finish.

Perhaps, like some other men in metalworking management, you look upon Heald Bore-Matics as strictly high-precision machines that couldn't (or shouldn't) be used for *roughing* operations. Actually, Heald Bore-Matics can be and have been designed most successfully, to provide whatever degree of precision you need—from drilling, reaming, tapping, slotting, rough boring, turning and facing, etc., to any combination of precision-finishing operations.

To precision specialists roughing operations present no problems and, of course, the precision operations are taken in stride.

On any automated job, make it Heald all the way—from rough casting to precision-finished part.

It PAYS to come to Heald for the completely automated job

HEALD

THE **HEALD** MACHINE COMPANY

Subsidiary of The Cincinnati Milling Machine Co.

Worcester 6, Massachusetts

Chicago • Cleveland • Dayton • Detroit • Indianapolis • New York

This 7-station Heald Bore-Matic performs 35 operations on a drum and sleeve assembly in a fully automatic cycle, as follows:

Sta. 1. Drill 6 angular holes and 2 opposed holes in hub.

Sta. 2. Bore, face, turn and chamfer 8 surfaces on flange and hub.

Sta. 3. Turn and face 9 different flange surfaces.

Sta. 4. Face 2 spots on flange.

Sta. 5. Bore, face and groove 5 different surfaces in hub and flange.

Sta. 6. Insert bronze bushing in inside hub.

Sta. 7. Finish bore bushing and finish turn hub.

Circle 651 on Page 141

He's been working on the railroad . . .

the TRS rivet man found a $7000 saving in A. C. Gilbert's train transformers

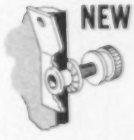
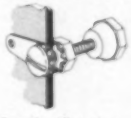
You needn't be rich to give your boy a fine American Flyer train because Gilbert never misses a possibility for reducing costs.

For example, they challenged a TRS sales engineer to find ways to save on transformer assemblies. He uncovered *two* . . . worth $7000 on a year's production.

Invite the TRS man to check over your assemblies. You'll find that he is more than a salesman . . . that he has the viewpoint of a manufacturing engineer. Chances are he can contribute practical ideas for making your assemblies simpler, faster, better.

Of course he sells rivets. And he can give you sensible reasons why TRS Tubular Rivets are more reliable in essential qualities and uniformity. Ask to see the TRS Quality Control Album . . . one significant result of a five-year modernization of this pioneer company. Modernization of people, policies, production and service facilities. *You'll like to do business with the new TRS . . . we'll make sure of it.*

SEE WHAT THE **TRS** MAN FOUND

OLD	NEW
	
Found: Contact fastener and binding post. Expensive brass stud machined from hex stock, 8/32 thread, and brass nut. Hex must be recessed in plastic to stop rotation.	**Suggested:** Low-cost 10/32 threaded collar rivet and nut of steel. Automatically clinched to hold firm without hex or recess. Underwriters' ok'd change to steel if 10/32 thread.
	
Found: Five-piece lug fastener and binding post . . . expensive 8/32 brass screw and hex lock nut, 2 lock washers, brass terminal nut.	**Suggested:** Low-cost threaded steel collar rivet and steel nut, 10/32 thread.

Don't Buy Riveting Machines until you learn how the TRS **PAR** *process revolutionizes riveting*

TRS®

TUBULAR RIVET & STUD COMPANY

QUINCY 70, MASSACHUSETTS • Midwest Office & Warehouse in Chicago. Branches: Atlanta, Buffalo, Charlotte, Cleveland, Dallas, Detroit, Hartford, Indianapolis, Los Angeles, New York City, Philadelphia, Seattle, Springfield, St. Louis. See "Yellow Pages" for phone numbers.

If it's a Tubular Rivet TRS makes it . . . and Better

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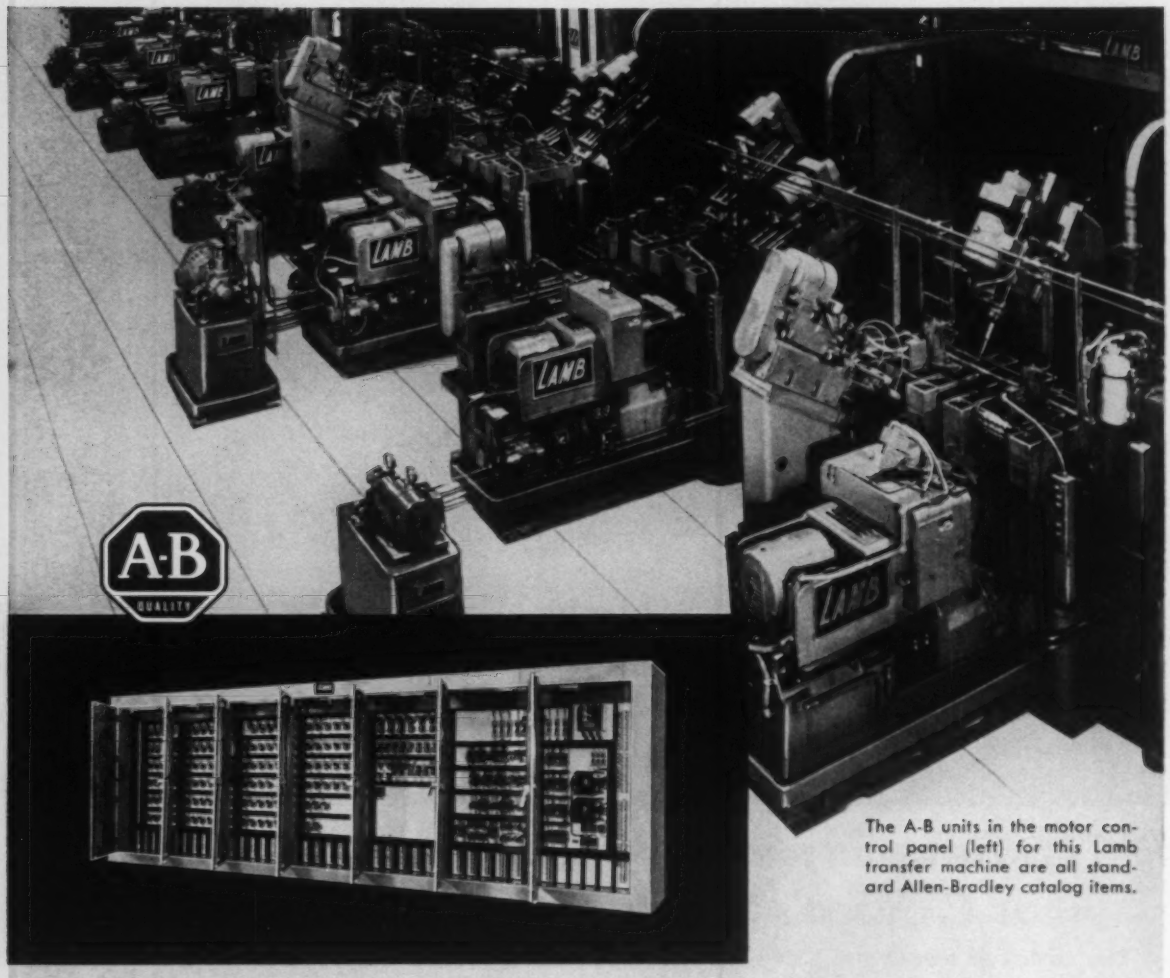

The A-B units in the motor control panel (left) for this Lamb transfer machine are all standard Allen-Bradley catalog items.

When only the best will do...

ALLEN-BRADLEY

Quality Motor Control

It's sound engineering to insist that your automatic production machines have the best in motor control ... and that means Allen-Bradley—the *quality* motor control.

Allen-Bradley motor control will provide the reliability you need. It's the simple solenoid design—around which *all* Allen-Bradley relays, contactors, and starters are built—that makes this possible. There is only ONE moving part ... all trouble causing bearings, pins, and pivots are eliminated. This is your assurance of *millions* of trouble free operations. And the double break, silver alloy contacts—standard throughout the Allen-Bradley line—never need service attention. They are always in perfect operating condition.

Protect your production machines from control failures ... insist on Allen-Bradley motor control. It's the *quality* line preferred throughout industry.

Allen-Bradley Co., 1339 S. First St., Milwaukee 4, Wis.—In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Another automatic production machine "goes Allen-Bradley"

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OCTOBER 1958
Vol. 5 — No. 10

AUTOMATION

A PENTON PUBLICATION

The Magazine of Automatic Operations

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automation outlook

ENGINEERED APPROACH REQUIRED

". . . manufacturing in the era of automation is no longer an art; it is fast becoming an engineering technology of broad, sweeping proportions. Truly, it can be said it has left the ranks of the shop man, the apprentice, the machinist, and millwright. To carry on competitive manufacture today requires an engineered approach, with full recognition that fundamental manufacturing problems are basic to all industries and eminently satisfactory solutions already exist for most all problems encountered; it takes broad knowledge and engineering acumen to achieve practical success . . ." —*Roger W. Bolz, editor,* AUTOMATION, *see page 44.*

ORGANIZED EFFORT

". . . to be successful, an automation program must be considered by all functions in the company: Marketing, finance, engineering, and personnel as well as manufacturing. To arrive at the best product design, manufacturing process, and factory layout to produce a product automatically requires a real team effort . . ."—*O. S. Hulley, consultant, Manufacturing Training & Education, General Electric Co., see page 50.*

BEST TIME TO AUTOMATE

". . . economic and technical feasibility of an automation program is never more probable than at the inception of a new product's design . . . At this time, there are no outmoded facilities to write off and physically dispose of, new equipment and tooling can embody latest technology, and a completely unbiased viewpoint can be adopted by product design and manufacturing groups working together . . ."—*John V. Allen, project engineer, Murray Mfg. Corp. and Theodore F. Aronson, president, Halm Instrument Co. Inc., see page 59.*

INDUSTRY, TECHNOLOGY, AND DEFENSE

". . . just as we exploit technology for peace and prosperity, we must also exploit it for national defense. Technology has no morals, it is not limited to America, it doesn't care who uses it. It works with equal impersonal efficiency and grim effectiveness for good or evil, for friend or foe . . . Military preparedness and industrial readiness are heads and tails on the same coin—they both must be geared to the ever-changing technology of this age . . ."—*J. Lewis Powell, Office of the Assistant Secretary of Defense.*

VAST MIDDLE GROUND

". . . the true value of automation to the vast majority of manufacturers lies somewhere between the much publicized electronic brains, the high and costly transfer machines of the automotive factories, and work simplification using air, hydraulics, and other power to replace muscle effort and electrical or electronic controls to replace brain or precision skill control . . ."—*Milton Alden, president, Alden Systems Co.*

BETTER METHODS ALWAYS SELL

". . . there is nothing so wrong with the economy that industry has stopped looking for better methods. When better methods are made available, they find buyers . . ."—*Marvin R. Anderson, president, Michigan Tool Co.*

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BPA NBP

For the engineer who refuses to stagnate

HALF the world is half asleep! Men who could be making *twice* their present salaries are coasting along, hoping for promotions but doing nothing to bring themselves forcefully to the attention of management.

They're *wasting* the most fruitful years of their business lives . . . throwing away thousands of dollars they may never be able to make up. And, oddly enough, they don't realize—even remotely—the tragic consequences of their failure to forge ahead while time is still on their side.

Engineers and other technically-trained men are particularly prone to "drift with the tide" because their starting salaries are reasonably high and promotions come at regular intervals early in their careers. It isn't until later—too much later in many cases—that they discover there is a definite ceiling on their incomes as technicians.

Send for Your Free Copy of "Forging Ahead in Business"

If you want to discover how to succeed while you are still young—if you want to avoid the heartbreak of failure in later years—send today for "*Forging Ahead in Business*" . . . one of the most practical and realistic booklets ever written on the problems of personal advancement.

Here you will find—not a "pep-talk," not an academic lecture—but cold, hard *facts* on how to improve your position and increase your income. You will be told what the qualifications of an executive are in today's competitive market . . . what you must *know* to make $15,000, $20,000 or more a year . . . what you must *do* to accumulate this knowledge.

"Forging Ahead in Business" was written for mature, ambitious men who seriously want to get down to bed-rock in their thinking about their business future. If you feel it is meant for you, simply fill in and return this coupon. Your complimentary copy will be mailed to you promptly.

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Circle 656 on Page 141

20 TON CRANES FLY AIRCRAFT SECTIONS IN CEILING

Lowering the tail boom of a large airplane into place. These huge units must be handled with extreme care and inched gently into exact position for matching of holes. The Cleveland Tramrail cranes used here are of the transfer type and carry loads to 20 tons.

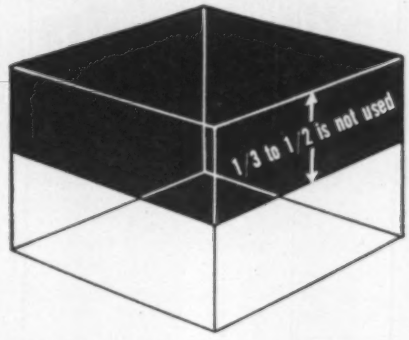
40-FOOT TUBES HANDLED FAST IN CEILING

5 ton Tramrail cab-operated transfer cranes move tubes at 300 f.p.m. to all points in this 58,000 sq. ft. room. To convey the tubes from bay to bay with floor trucks would be awkward, slow and require considerable valuable floor space. The two hoist hooks are 16 feet apart and have a lift of 30'-0".

LOOK TO YOUR CEILING

For Big Savings

1/3 to 1/2 the cubic space in the average plant is NOT USED



MANY plants are pinched for floor space, yet are not using a large part of their cubic footage. Much of their large ceiling space is wasted.

By moving all equipment and activities possible from floor to ceiling, many square feet of floor are freed for the addition of production machinery without plant expansion for needed storage areas and other requirements.

Aisleways can be reduced in size or completely eliminated. Machines can be moved closer together. Floor areas used for local stocking can often be done away with.

Materials handling is an operation that can be carried on efficiently overhead. Cleveland Tramrail equipment is handling vast tonnages of materials in the ceilings of thousands of factories and warehouses. Not only do Tramrail cranes and track systems save tremendous areas of floor space, but they speed handling, lower production costs, often by fantastic amounts, and greatly aid safety.

We welcome an opportunity for a Cleveland Tramrail materials-handling engineer to give you the details.

Write for free Engineering and Application Booklet No. 2008. Packed with valuable information.

CLEVELAND TRAMRAIL

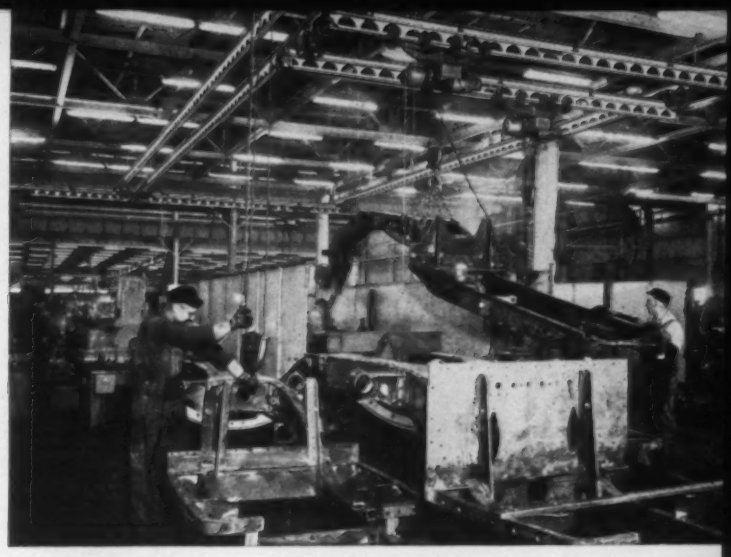
Overhead Materials Handling Equipment

CLEVELAND TRAMRAIL DIVISION
THE CLEVELAND CRANE & ENGINEERING CO.
1332 East 290th Street, Wickliffe, Ohio

Circle 657 on Page 141

TRAMRAIL CRANES PERMIT LOWER HEIGHT OF CEILING

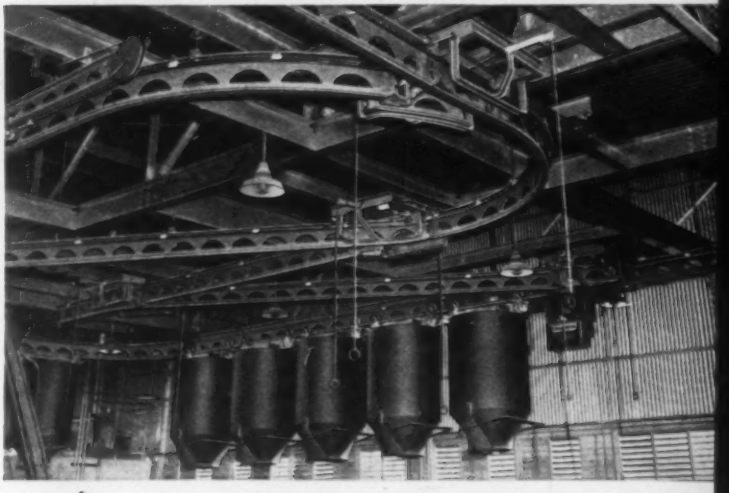
Both ordinary top-running and Tramrail under-running cranes were considered when this Diesel Repair Shop was planned. Two 5 ton, 63'-0" Cleveland Tramrail cranes were installed. Among other advantages, they enabled a lower building height. This shop is thought to be the finest and most modern of its kind.



TRACTOR PLANT PROFITS BY USING CEILING

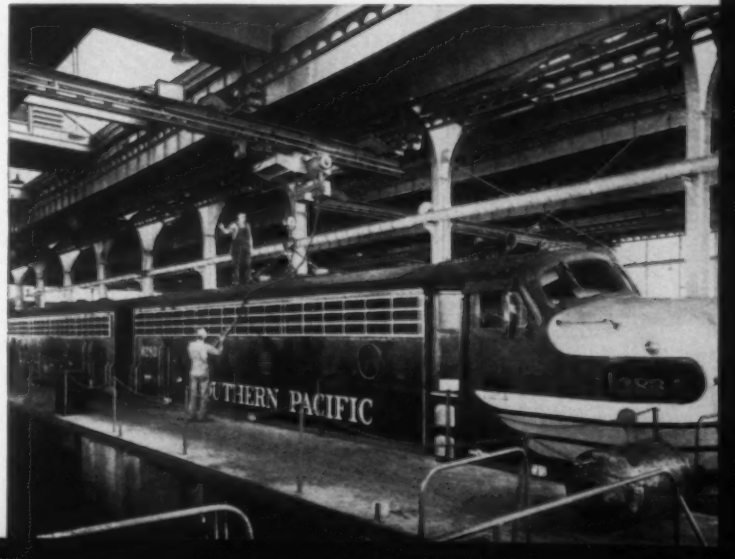
Heavy materials can be moved quickly, easily by one man in every square foot of a plant covered by Cleveland Tramrail cranes.

Some 250 cranes, like those illustrated, eliminate waste time waiting for a lift in this efficient plant.



TRAINS OF BUCKETS CONVEYED IN CEILING

Buckets of materials can be conveyed on Tramrail track and switch system in ceiling by powerful tractor. Control can be automatic if desired. Each bucket in train illustrated has 45 cu. ft. volume and 4000 lb. capacity.



T-J spacemaker cylinder

Quality Engineered

to give quality results

with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. IMMEDIATE SHIPMENT in a wide range of styles and capacities, with 64,000 combinations. Write for Bulletin SM 155-3 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVITORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

NEW "SUPER" CUSHION FOR AIR . . . Standard at No Extra Cost!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

ONE PIECE PISTON . . . Standard at No Extra Cost!

NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . Standard at No Extra Cost!

NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

Circle 658 on Page 141

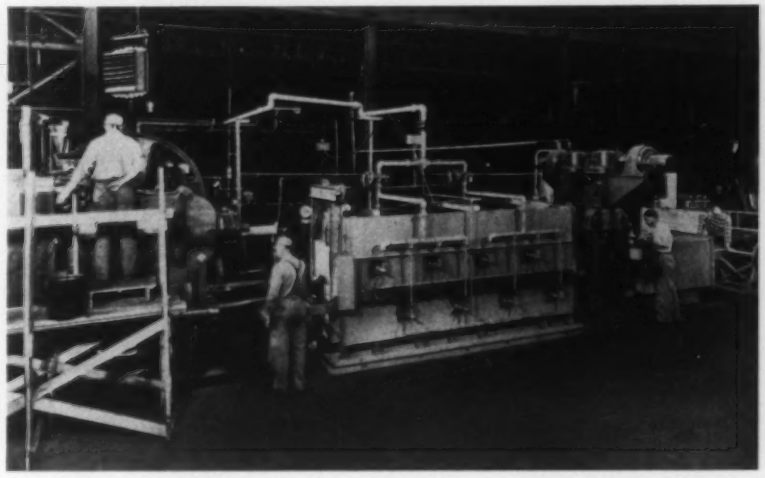
AUTOMATION news

Today's events and developments in the field of automation

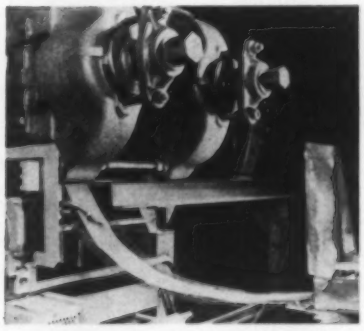
Hot Rolled Strip from Metal Powder Commercially Feasible

PRODUCTION of high-quality hot rolled strip from metal powder has been perfected on a pilot sintering line developed by E. W. Bliss Co. after more than six years of research in co-operation with Chemetals Corp., patent holder and licensors of the process. While most development work has been in manufacturing copper strip, the system has shown practical application to many other metals with experimental work on nickel showing much promise. The economic implications of the new process are great for it is possible to produce strip from powder at savings of about 80 per cent of conventional equipment and rolling costs.

The E. W. Bliss Co. is now in a position to make complete "turn-key" installations of equipment to produce strip from metal powder. In addition to savings in equipment and rolling costs, tests have found that copper strip produced by the new process has higher tensile strength and lower oxygen content than conventionally produced electrolytic grade copper strip.



PILOT LINE at an E. W. Bliss Co. plant produces copper strip from metal powder. Hopper at top left feeds metal powder to green compacting rolls directly beneath. Continuous strip emerges from mill and passes through sintering furnace to hot mill rolls at right. Finished strip is wound into 100 to 200-pound coils at extreme right.



SIX-INCH wide strip of green compact emerges from mill in a continuous length of uniform thickness and density. Process produces copper strip having higher tensile strength and lower oxygen content than conventionally produced strip.

The strip is made from fine metal powders which are chemically produced. The powders are fed through a mill for green compacting to a uniform thickness and density. From the mill, a continuous strip of green compact passes into a protective atmosphere heating furnace for sintering, and, upon emerging, is immediately hot rolled. Depending upon the type of powder used, the strip can be heated and hot rolled again to produce metal completely consolidated to its normal density. The pilot line equipment is capable of making copper strip 6 inches wide, 0.040 inches thick, and coiled into rolls that weigh 100 to 200 pounds.

Many production problems were solved during the course of the experimental program on the pilot line machine. For example, special rolls and feed devices had to be developed before it was possible to produce green compact of uniform thickness and density, with edges that were uniform, sound, and square. Considerable research was done in the fields of protective atmosphere, sintering time, and sintering temperatures in collaboration with the Electric Furnace Co. The end result of the research was the development of equipment capable of producing metal strip on a commercial basis comparable or superior to conventionally produced strip.

GE Offers Six Numerical Positioning Control Packages

DEVELOPMENT of a complete line of packaged numerical positioning controls has been announced by General Electric Co. Included in the line are six pre-engineered, packaged units designed to provide semi-automatic or automatic control of

point-to-point positioning and to direct from one to five linear or rotary motions of a machine or machine tool. The units are designated Mark I-M, I, II, III, IV, and V according to the number of motions they are capable of performing.

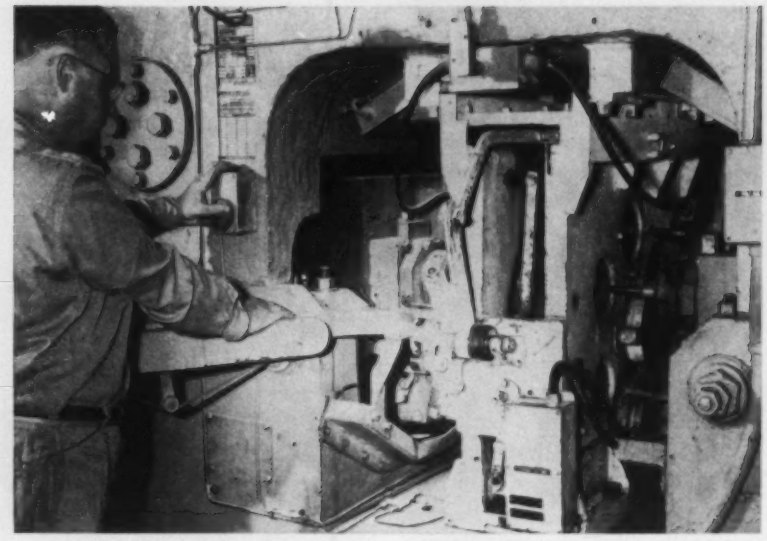
The standard design units range in price from $5140 for the Mark I-M to $32,990 for the five-motion Mark V. Mark I-M is directed from manually set decade switches only and is semiautomatic in operation. The remaining five standard units operate from numerical data stored in eight-channel, 1-inch wide punched tape or manually set decade switches. Motors, operator's control, position pickup units, and tape reader are included in each package. Tape control of nonstandard auxiliary functions is accomplished by the addition of relays or other electrical devices in the field or at the factory.

The units offer speeds up to 200 inches per minute or faster speeds with reduced accuracy. The controls provide for sequential or simultaneous linear and rotary positioning and have electrical accuracies of plus or minus 0.0005 inch at travel lengths up to 99.999 inches. Modifications to the units will permit length of travel up to 399.999 inches. Four choices of drives are available. They include a special Thymotrol adjustable speed dc motor drive, dc positioning motors controlled by amplidynes, electrohydraulic motor, or electrohydraulic piston.

High Temperature Masking Tape

PRESSURE-SENSITIVE masking tape capable of withstanding temperatures up to 425F for several hours has been announced by Permacel Tape Corp. The tape combines a specially treated backing with a newly developed adhesive formulation which gives the tape resistance to high heat, long baking cycles, moisture, and solvents.

Extreme thinness and flexibility combine to allow easy application on curved or irregular surfaces and reduce paint build-up along the tape edges. The tape will not stain metal surfaces to which it is applied, and, after baking, the tape strips off easily and cleanly. It is recommended for use on specially treated surfaces such as anodized or alodized aluminum and dichromated magnesium. High temperature resistance insures that the new tape will adhere tightly to surfaces without shrinking or curling while baking.



COLD EXTRUSION production method is used at the new Lima engine plant of Ford Motor Co. to produce piston pins from steel slugs. The 2⅛-inch long slugs, coated with phosphate and a liquid soap lubricant, are automatically positioned in the extrusion press. Carbide punches, mounted on two rams of opposing forces, strike the ends of the slug with 100-ton pressure. The large force causes the cold metal to flow into a die forming the piston pin. Flat punches strike the pin to square the ends, and then the 3½-inch long pin is automatically ejected from the press. The press is capable of producing over 1900 piston pins an hour. Cold extrusion method of making the hollow piston pins replaced a time consuming and wasteful drilling operation on a 3½-inch long steel slug.

AMA Seminar to Study Materials Handling Phase Of Automation

MATERIALS HANDLING Seminar will be held in Cleveland on October 20-22 to discuss the topic of "Materials Handling and Work Flow for Job Lot Production." Sponsored by the American Management Association, the 2½-day meeting will be presided over by **Roger W. Bolz**, editor, AUTOMATION.

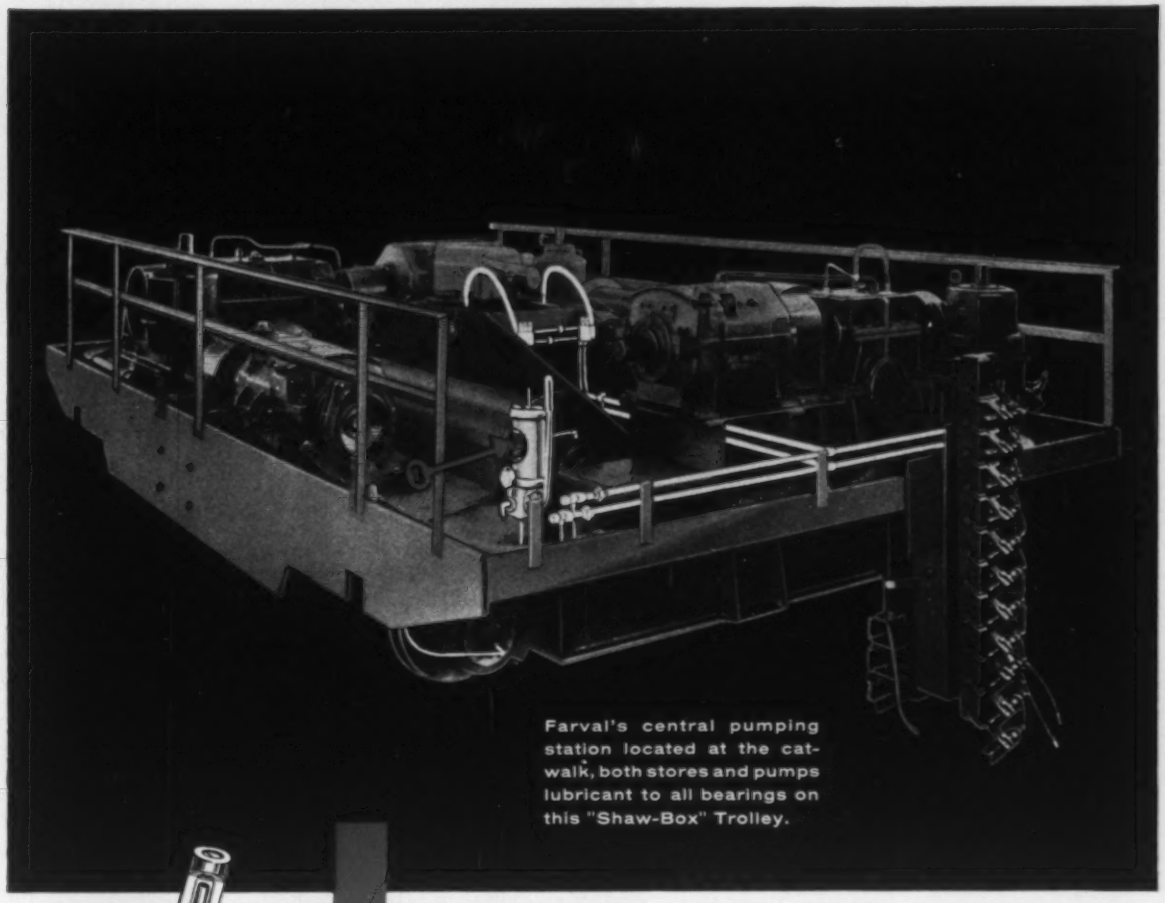
The seminar will provide an over-all picture of what is successfully being accomplished to reduce costs in job lot operations in one major area of automation—materials handling. This will include discussions on the use of bulk feeders in integrated lines, discrete feeders to machines, automatic handling between machines, and warehousing handling by tape control. Other interesting subjects tying together the seminar package will be discussions on how to get started in automation and how to plan a successful automation program.

Past seminars have proved valuable to operating executives responsible for initiating, developing, or administering cost-saving methods through the proper flow of work. Registration for this seminar can be made through the AMA headquarters, 1515 Broadway, New York 36, N. Y.

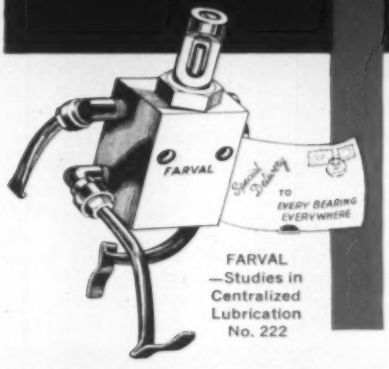
Old Company Gets New Name In Expansion Of Services

RECENTLY announced by General Precision Equipment Corp. was a change in name for one of its major subsidiaries, Askania Regulator Co. The subsidiary will be known as GPE Controls Inc.

Products and services of GPE Controls will include the pneumatic, hydraulic, and electrohydraulic process control systems formerly offered by Askania. By integration with certain products and technical services of three other subsidiaries of General Precision



Farval's central pumping station located at the catwalk, both stores and pumps lubricant to all bearings on this "Shaw-Box" Trolley.



FARVAL
—Studies in Centralized Lubrication
No. 222

Farval helps 200-ton "Shaw-Box" Crane deliver dependable performance

RUGGED "Shaw-Box" cranes, built by Manning, Maxwell & Moore, Inc., moving plates, slabs or giant ladles in steel plants across the nation are noted for safe, dependable service under extreme operating conditions. One big reason for this performance is proper bearing lubrication . . . provided by Farval.

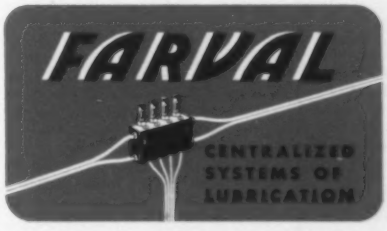
Farval's up-to-the-minute method sends measured amounts of lubricant to all crane bearings from a safe, centrally-located pumping station. Thus the need for men to crawl over the crane with hand grease guns is eliminated.

To see how Farval can help you cut operating costs, ask for revised Bulletin 26-S. Write today to The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

KEYS TO ADEQUATE LUBRICATION

—wherever you see the sign of Farval—familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine is being properly lubricated.



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Equipment Corp.—Librascope Inc., Link Aviation Inc., and Kearfott Co. Inc.—GPE Controls will offer analog and digital process control computers, data logging equipment, flow computers and integrators, analog-digital converters, and precision mechanical, electronic, and hydraulic components and subsystems.

In making the announcement, **Edwin A. Link**, president of the parent corporation, said, "GPE Controls is in a position to design and install complete control-computer systems in virtually any industry—natural gas, chemical, petrochemical, steel and nonferrous metals, metal fabrication, textile, paper, plastics, and printing." Shand and Jurs Co., another subsidiary of the parent company, will continue to serve the petroleum and pipeline industry. Compatibility of the products of Shand and Jurs and of GPE Controls is assured under the new program, Mr. Link said.

Unusual Program Format Planned For EIA Conference

PARTICIPANTS at the 3rd EIA Conference On Reliable Electrical Connections on December 2-4 will be exposed to a novel technique for technical meetings. Instead of spending valuable time in listening

Tear Out Old Mill, Install New In Record 20 Days

INSTALLATION of a modern, six-stand, 30-inch billet mill was accomplished in twenty days at the Monessen, Pa., works of the Pittsburgh Steel Co. In a unique engineering feat, the new rolling mill was erected around existing facilities that continued to produce billets and tube rounds during months of preliminary construction. Final race against time allowed twenty-one days to dismantle the tables, two stands, conveyor beds, and shears of the old 28-inch mill and erect the new mill. The first bloom rolled on the $6 million billet mill one day ahead of the scheduled completion date.

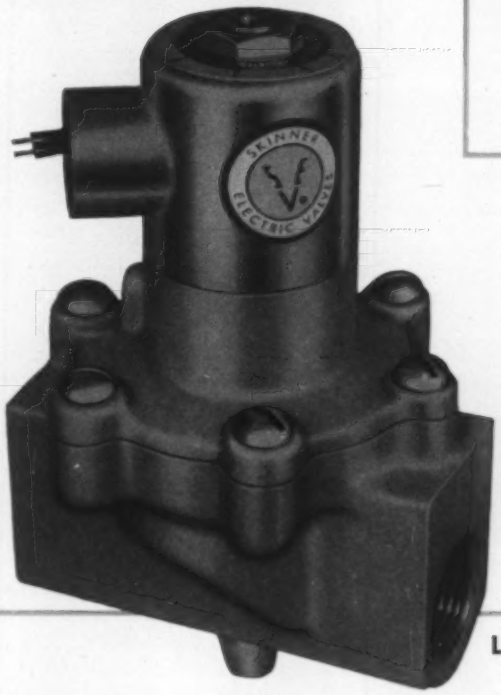
With the completion of the new mill and the recent renovation of other primary rolling facilities, Pittsburgh Steel is now equipped with one of the most modern rolling mills in the nation. Part of a $111 million cost reduction program, the new 30-inch mill rolls blooms from 9 x 10 inches down to 4-inch squares for wire products and 4⅝-inch rounds for seamless tube production. The United Engineering & Foundry Co. mill consists of three horizontal and three vertical stands individually powered by 1750-hp General Electric Co. motors. Auxiliary controls and switch gear were supplied by Westinghouse Electric Corp.

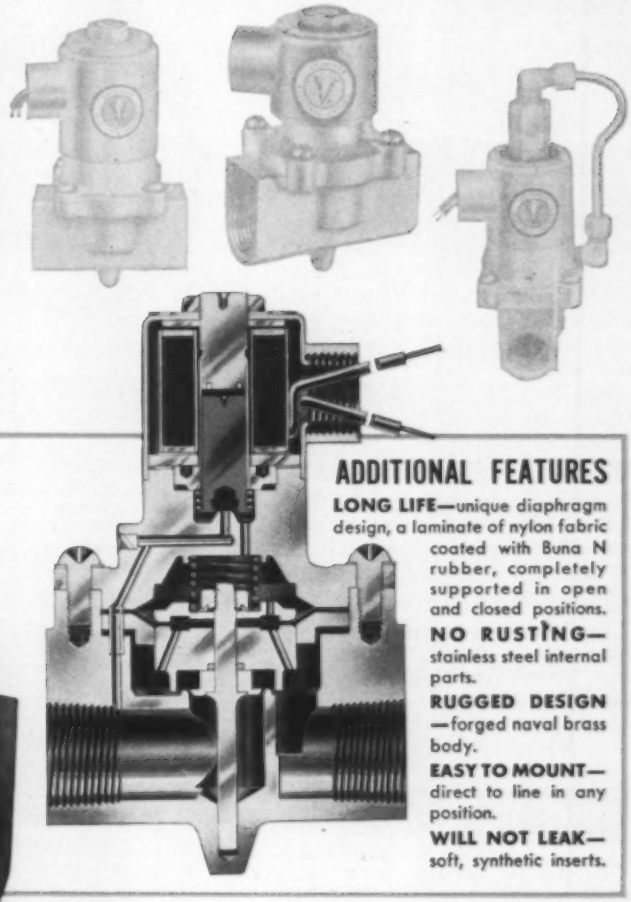
Preliminary construction was begun several months ago with the temporary installation of one of the new 1750-hp motors to drive the second stand of the old mill. The remaining five motors, the new mill stands, and the gear drives were installed as steel continued to be rolled on the old 28-inch mill. On August 1 Pittsburgh Steel engineers and the contractor, F. H. McGraw & Co., began working on a round-the-clock basis to tear out the old mill. Then the new mill was constructed over the foundations and oil cellar that had been completed while the old mill was still in operation. Entry, transfer, and delivery tables were installed. The temporary drive motor of the old mill was relocated to drive the sixth stand of the new mill. In twenty days the job was accomplished, and the first blooms were being processed through the new mill.

WORKING on a round-the-clock basis, construction crews dismantle the old 28-inch billet mill (above) as other crews erect the new six-stand, 30-inch mill. Because preliminary installation work was done on the new mill while the old mill continued in operation, the complete changeover was completed in a record time of 20 days. At the completion of the job, construction crews watch the first bloom enter the United Engineering mill (right). The new $6 million billet mill and renovation of other rolling facilities provides Pittsburgh Steel Co. with one of the most modern rolling mills in the nation for the production of rounds for seamless tubes and squares for wire products.

New low-cost, high-flow, 2-way valves with . . .

DEPENDABLE SKINNER QUALITY





ADDITIONAL FEATURES

LONG LIFE—unique diaphragm design, a laminate of nylon fabric coated with Buna N rubber, completely supported in open and closed positions.

NO RUSTING—stainless steel internal parts.

RUGGED DESIGN—forged naval brass body.

EASY TO MOUNT—direct to line in any position.

WILL NOT LEAK—soft, synthetic inserts.

L SERIES

These L Series valves with ¾″ and 1″ diameter orifices complete an *all new* line of 2-way valves previously introduced in January in the ⅜″ and ½″ sizes.

Manufactured to the highest engineering standards, these pilot-operated, high-flow industrial valves are a welcome addition to the famous Skinner solenoid valve line. They are smaller and more compact than the M2 Series they replace and feature a unique diaphragm design. They are also considerably lower in cost. The ¾″ size, for example, will cost you 51% less.

These larger L Series models – ¾″ and 1″ – will be available in standard and Explosion-proof construction, normally open or normally closed. They operate on a pressure differential of 5 to 150 psi and will control such common media as air, oil and water.

For complete information, please contact our Representative or Distributor near you . . . you'll find him listed in the yellow pages or write us at the address below, Department 320

SKINNER ELECTRIC VALVES
THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE

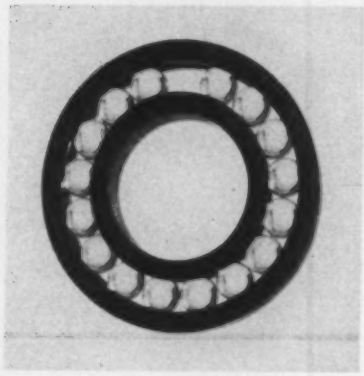
Circle 660 on Page 141

to presentations of technical papers, the papers will be published and offered for sale in October so that participants may read them thoroughly and use the conference time for questioning the authors. Therefore, the entire conference time can be profitably spent in getting answers to technical questions from men who are specialists in their fields.

Sponsored by the Electronic Industries Association, the conference will have no planned lunches or dinners and no exhibits. The conference will discuss every known type of electrical connection and the material and processes which make it. Participants will have the opportunity of acquiring the specific knowledge they seek, and, at the same time, contributing their knowledge to others.

Mixed Valence Compounds Convert Heat To Electricity

DISCOVERY of a new class of materials which can convert the heat of a burning fuel, or other high temperature source, directly into electricity has been announced by



BALL BEARING developed by Halax Corp. utilizes Pyrex balls running in linen base phenolic races for nonconducting, corrosion-resistant bearing applications. Depending upon the type of phenolic used in the races, bearing can be run in water, acids, oils, and other environments that would adversely affect steel bearings. Glass balls and plastic races also make bearing applicable in areas affected by magnetic fields.

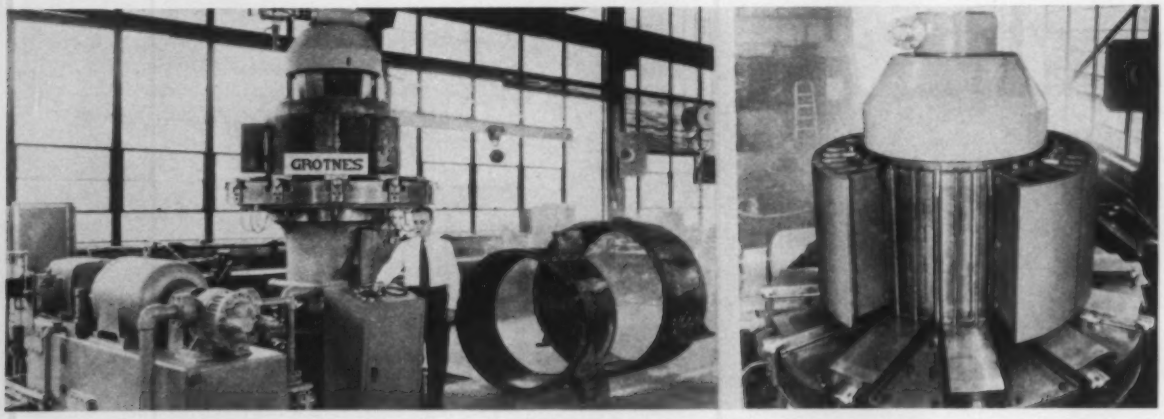
Dr. Clarence Zener, director of research, Westinghouse Research Laboratories.

The new Westinghouse thermoelectric materials are technically described as "mixed valence compounds of the transition metals." Valence is the amount of electric charge displayed by atoms in a chemical compound. In mixed valence compounds, atoms of the same element have different amounts of charge within a single molecule of the compounds.

Transition metals are a group lying near the center of the natural table of elements and include such common examples as iron, nickel, and manganese. According to Dr. Zener, the new thermoelectric materials are the first to be discovered in the general category of substances that characteristically are insulators or nonconductors of electricity. Dr. Zener said, "These thermoelectric materials are ceramics, the same broad group of substance that includes such common substances as pottery and brick. As far as we know, our ceramic-type materials are the first solid-state thermoelectric substances to operate with what we consider are promising efficiencies at temperatures in the range of 2000 to 3000F."

"Being ceramics, they are inherently stable and chemically inactive, even at very high temperature," Dr. Zener said. "They can be heated indefinitely in air with an open flame without deterioration; they do not require chemical preparation to an extreme degree of ultrapurity; their use raises no technological problems of high-vacuum operation, complex electrical or electronic apparatus, or the like."

Dr. Zener stated that work with the new thermoelectric materials is still in its early stages, and they do not exhibit the efficiency demanded by conventional methods of



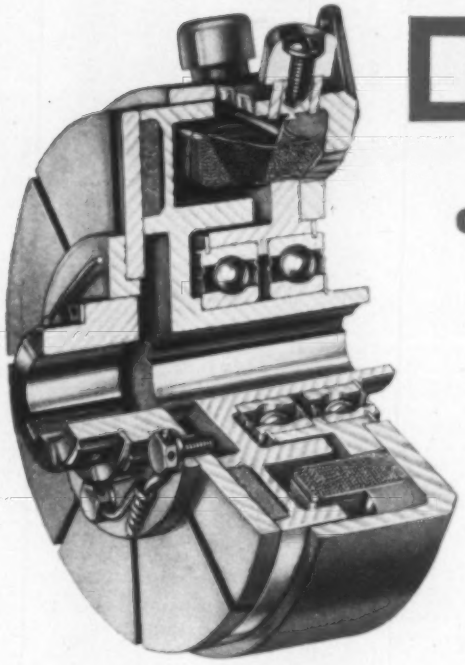
HYDRAULIC EXPANDER machine built by Grotnes Machine Works develops more than 1580 tons of force in expanding and sizing a steel ring weighing over 1½ tons. Two rings expanded and sized on the machine are shown in the left photo. The largest ring is 60 inches in diameter, 26 inches in height, and has a 2-inch thick wall. It was sized to within plus or minus 0.010 of a true circle in only one minute with no heating of the ring—the power applied being so great that the metal flows cold to the desired size and diameter. Closeup of the machine head showing the expanding jaws and 6-foot diameter table is at the right. Cost of machine will be amortized in less than 18 months through material and labor savings. Old method of manufacturing part reduced a 2½-inch thick wall to 2 inches in a rough turning operation that removed ½-inch of metal. For new method part is manufactured with a 2-inch wall, eliminating turning operation. Ring can be as much as 1-inch out-of-round when placed on machine as expander performs both sizing and rounding operations simultaneously.

New—Small Sizes!

EATON DYNA-TORQ

MAGNETIC-FRICTION CLUTCHES and BRAKES

Now Available in a Full Line from 1¾" to 15" Diameter



STATIONARY-FIELD, BEARING-MOUNTED DYNA-TORQ CLUTCH

Eaton Dyna-torQ Magnetic-Friction Clutches and Brakes provide a simple, accurate, responsive method of controlling power and motion in today's complex production and processing machines.

The new smaller sizes and new design types of Dyna-torQ Stationary-Field Clutches and Brakes enable Eaton to offer a well rounded line, including flange-mounted and bearing-mounted clutches, and replaceable-face brakes. Unique features of design and construction result in worthwhile maintenance cost savings. Dyna-torQ units, easily and quickly installed on new machines or existing plant equipment, deliver many highly desirable advantages.

Dyna-torQ Magnetic-Friction Equipment Offers these Important Advantages:

- ★ Accurate power control
- ★ Dependable motion control
- ★ Rapid response
- ★ Easy "built-in" installation
- ★ Low maintenance costs
- ★ Compact plug-in type controls—may be remotely mounted
- ★ Inter-changeability of parts

Send for this new illustrated bulletin giving complete description and specifications covering Dyna-torQ Stationary-Field Clutches and Replaceable-Face Brakes.

EATON

Dyna-torQ Equipment is Available through Dynamatic Distributors in all Leading Cities

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

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How to "Turn on a Dime"

Today, production men must "turn on a dime" to meet changing output requirements. One day sales are off—machines are idle; the next equipment must produce at top speed to meet a rush order. This requires unusual flexibility in both men and machinery.

To help solve this problem, General Electric offers a new, packaged, adjustable-speed drive—the Speed Variator. Offering wide speed ranges and good regulation, it can help your machines produce a greater variety of goods, faster and at lower cost per unit.

Find out how this versatile new drive can help you keep pace with today's fast changing production demands. Write for GEA-6643. *Direct Current Motor and Generator Department, Erie, Pennsylvania.*

813-20A

Progress Is Our Most Important Product

GENERAL ELECTRIC

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HANDLING galvanized water heater tanks in and out of storage by using a fork lift truck equipped with a Vac-U-Lift Co. vacuum unit has produced labor savings amounting to 40 per cent at the Milwaukee plant of Hotpoint Co. Previously, two men were required to manually load, unload, and stack tanks from a trailer-train. The vacuum method shown provides faster handling and a better utilization of space through higher stacking. The vacuum lifting units are designed to grip the curvature of tanks of various diameters.

power generation. Westinghouse does not anticipate the thermoelectric power will make obsolete present methods of generating large-scale quantities of electricity. If large-scale thermoelectric power does prove feasible, its function likely will be to supplement conventional methods or provide power where conventionol methods are undesirable or impractical.

Service Provides Graphs

AVAILABILITY of a new service for business executives has been announced by Service Bureau Corp., subsidiary of IBM. The service provides that the great amount of data being produced by modern digital computers can be converted automatically into the more meaningful format of graphs, curves, and mechanical drawings. This method of automatically presenting data in graph form is made possible by the installation of a new model Dataplotter, an electronic machine manufactured by Electronic Associates which quickly and accurately reads information from punched cards and plots it.

Line graphs are perhaps the most common method of presenting information upon which management decisions are based. In almost every area of commerce and industry, executives utilize graphs to evaluate production fluctuations, inventory levels, and sales totals. Executives located in all parts of the country will have the opportunity to utilize this service on an hourly basis through local SBC offices.

SCIENTIFIC apparatus maker has developed an automatic gaging and sorting machine which checks bearings and small parts to three-millionths of an inch tolerance, handling them as fast as 7000 an hour.

SPOTLIGHTING PEOPLE

McLain B. Smith appointed vice president and general manager of the Data Processing Div., International Business Machines Corp. . . . **Stelios Regas**, formerly with Tracerlab Inc., joined Radiation Counter Laboratories Inc. to head a newly formed industrial applications division. . . . **Chrysostom B. Blanchard** appointed superintendent of the Gage Div., Pratt & Whitney Co. . . . **Pressly H. McCance**, recently retired as president of Duquesne Light Co., joined Edwin L. Wiegand Co. as assistant to the president with

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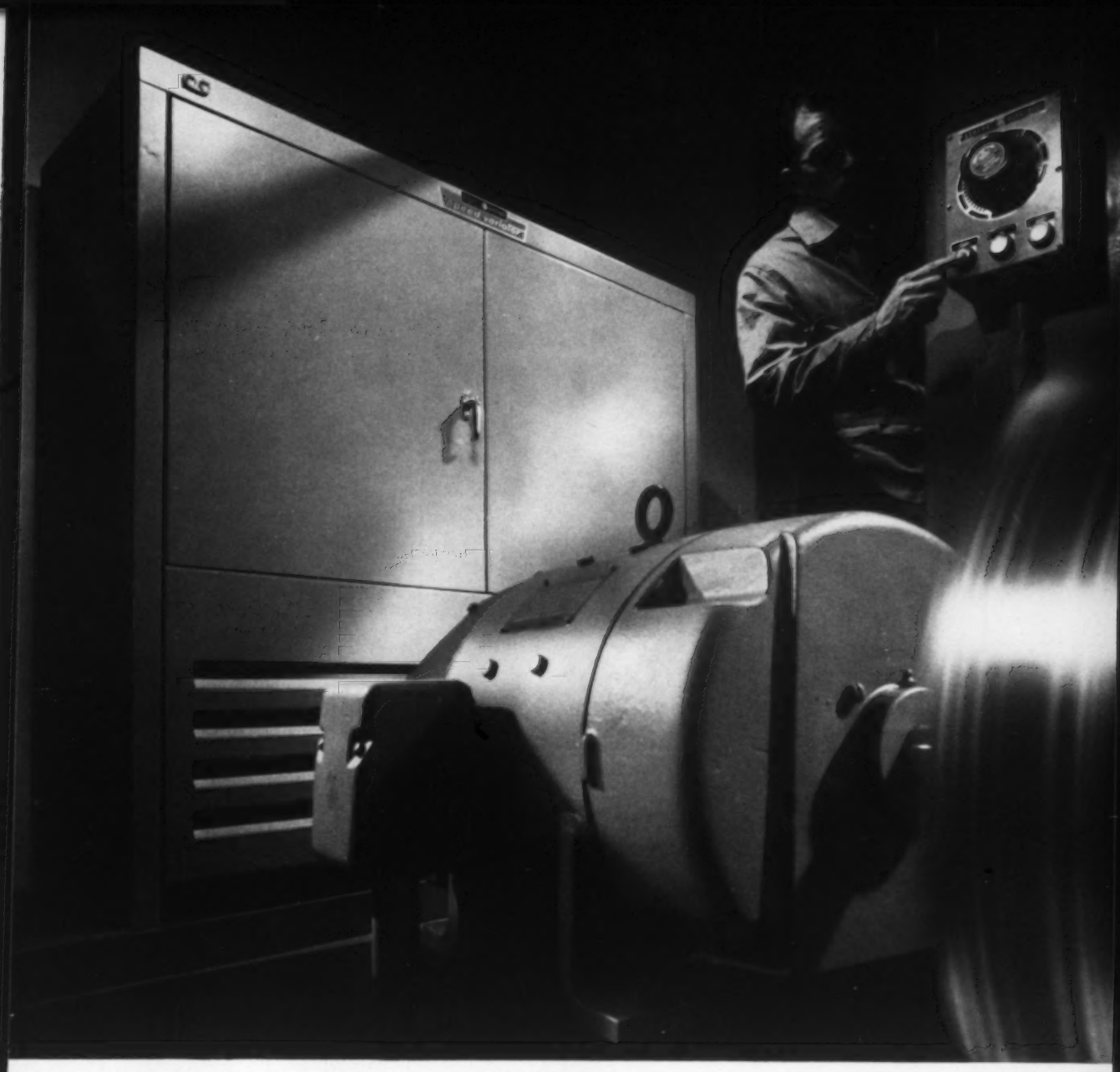


5 REASONS WHY YOU SHOULD BUY—

New General Electric Speed Variator

1. Amplistat Regulator offers better speed regulation and adjustable, timed acceleration for improved product quality.

2. Static Exciter, with silicon rectifier, has no moving parts, requires no warm-up, provides more production time, less maintenance.

3. Two-Unit, Four-Bearing M-G Set features Tri-Clad† '55' motor for more dependable performance.

4. Front-Connected Controls, recessed wiring troughs make routine inspection easy, cut maintenance time.

5. Kinamatic* Drive-Motors have field coils encapsulated for longer life. For details on this dependable motor see next page.

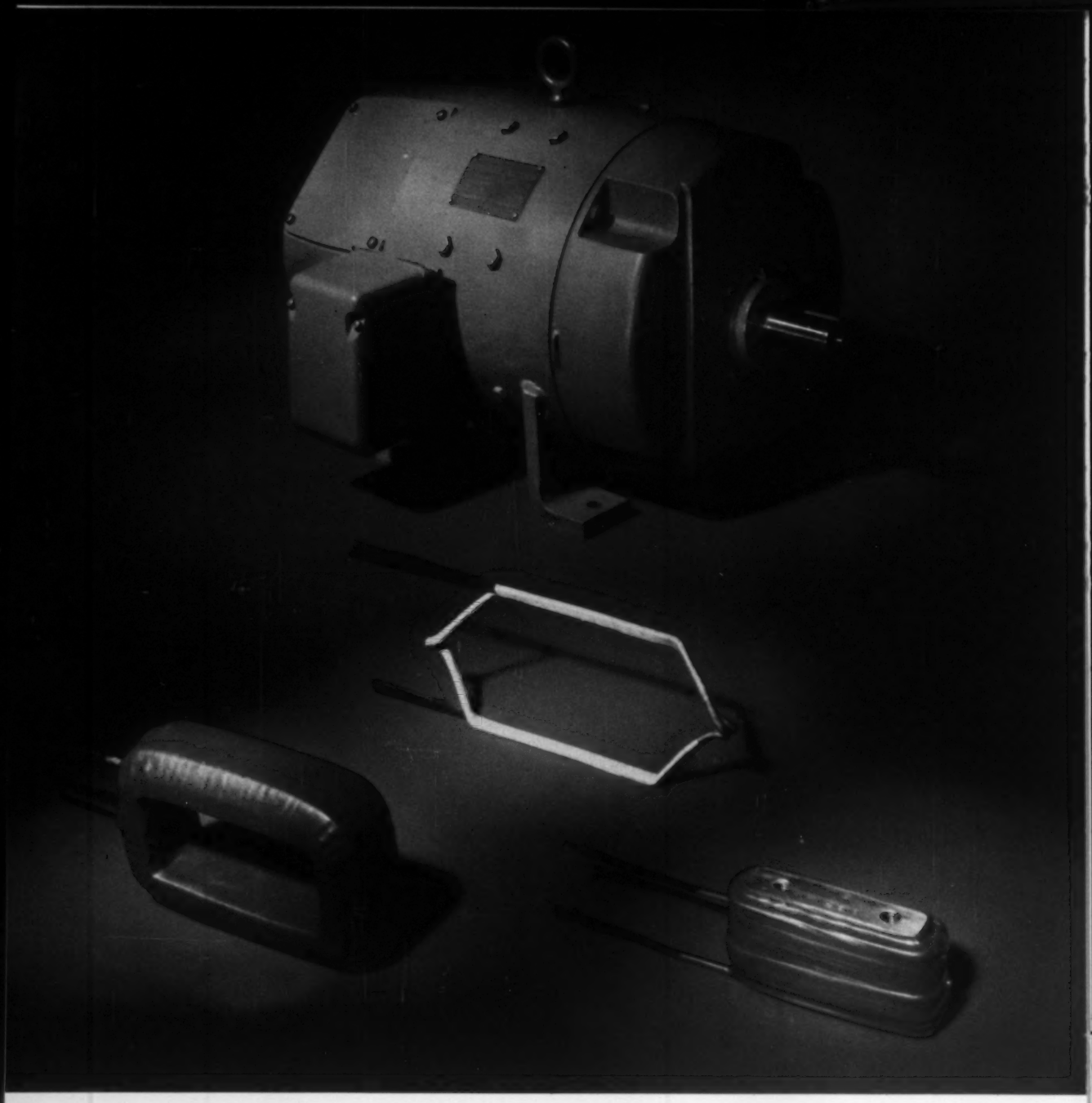
For more information contact your Apparatus Sales Office or write for GEA-6643. *Direct Current Motor & Generator Department, Erie, Pennsylvania.*

In Canada, contact Canadian General Electric, Peterborough, Ontario.

† *Registered Trade Mark General Electric Co.*
* *Trade-Mark of the General Electric Co.* 823-12

GENERAL ELECTRIC

More On Kinamatic Motors



NEW GENERAL ELECTRIC DC MOTOR HAS

Coils Encapsulated for Longer Life

KINAMATIC* ... *a new standard in industrial direct-current motors* ... designed to give extra dependability to automated production systems.

Encapsulated Field Coils ... insulated with mica and glass and permanently sealed against moisture and corrosive airborne materials ... virtually eliminates insulation as an element in motor life and adds a reliability factor never before available in a standard direct-current motor.

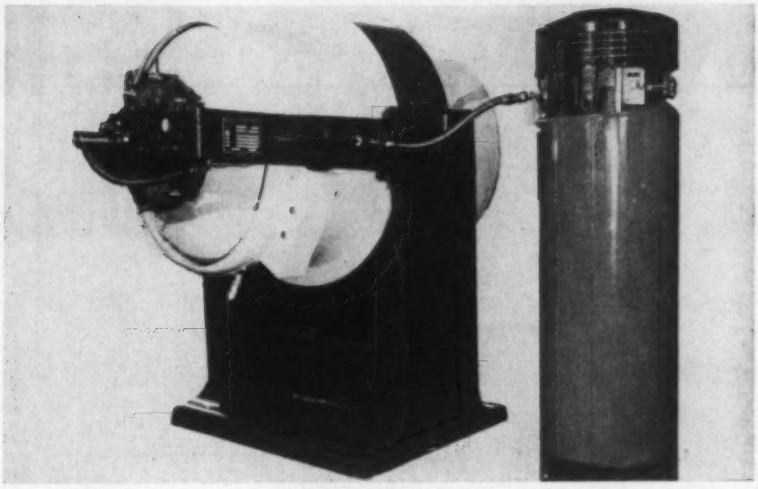
Greater Versatility ... a 15% service factor now available in the standard, dripproof d-c Kinamatic motor means user can: 1) obtain 15% more than rated power for normal life of motor; 2) obtain 100% longer motor life at rated power; or, 3) obtain greater versatility on speed and horsepower duty cycles.

Additional information is available at your nearest General Electric Apparatus Sales Office. Or, write for Bulletin GEA-6355. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.*

*Trade-Mark of General Electric Company. 813-12

Progress Is Our Most Important Product

GENERAL ELECTRIC



BORROWING from the tumbler concept used in the metal casting industry, Ryan Industries has perfected a new technique for removing flash or burr from silicone rubber molded parts. The rubber parts are loaded into the tumbler shown and are automatically frozen through the use of liquid nitrogen at a temperature of approximately 320 F below zero. As the barrel of the machine rotates, the abrasion of one part tumbling into another safely breaks off the flash or burr to produce smooth parts in quantity with high product uniformity. The 200-pound capacity machine operates with 100-psi internal pressure and is considered safe as production machinery. A quick dumping feature is designed to save time in unloading small and medium size parts on a volume basis.

the principal assignment of co-ordinating the company's relationships with electric utilities throughout the country. . . . **Howard S. Bean**, recently retired from the National Bureau of Standards, retained as consultant on flow measurement by Foxboro Co. . . . **James A. Perham** named chief engineer of Speedway Mfg. Co., Div., Thor Power Tool Co. . . . **Norman A. Fletcher** appointed manager of manufacturing for the Valve Div., Minneapolis-Honeywell Regulator Co. . . . **Lester W. Buechler** appointed general sales manager and **Joseph L. Behr** named chief engineer of the Electric Products Div., Vickers Inc. . . . **Frank V. Kupchak** appointed manager of the standards department, Materials Engineering Dept., Westinghouse Electric Corp. . . . **Thomas A. Kennedy** appointed vice president-general manager of the Fluid Control Div., Zurn Industries Inc. . . . **Guy K. Patterson** appointed chief engineer of Sierra Electronic Corp., subsidiary of Philco Corp. . . . **Howard S. Gleason** named manager of the Los Angeles Electronic Control Systems plant, Stromberg-Carlson. . . . **Robert W. Pearson** appointed director of manufacturing, Government Products Group, American Machine & Foundry Co. . . . **John B. Olson** named chief engineer of Computer Measurements Corp. . . . **Roger D. McCoy** joined the consulting engineering firm of Dudley Deane and Associates as industrial engineer on automation.

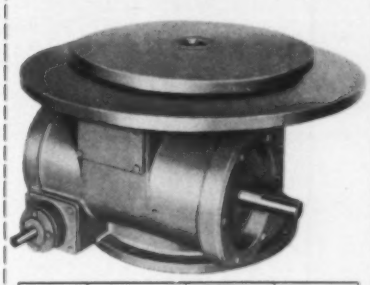
SPOTLIGHTING PRODUCTS

High temperature thermistors which function continuously at 1200 F are available from Fenwal Electronics Inc. The bead units come in bare form with attached leads and without glass coating. They have a resistance of 250,000 ohms at 25C, 0.7 dissipation constant, and 2 sec time constant. Completely stable at 1200 F, the thermistors can be used up to 1800 F with moderate stability. . . . *Engineers slide rule* to speed frequency response calculations is offered by Frederick Post Co. It gives magnitude ratio and phase response angle in one setting. Frequency responses of physical systems can be obtained with the slide rule when the transfer functions of the systems are the products of real linear and exponential factors. Scales for direct conversion from decibels to actual magnitude, and from angular frequency to frequency or period time, are also provided. . . . *Capillary tubing* in continuous lengths up to 3000 feet is available from Superior Tube Co. Maximum length of tubing fur-

STANDARD TOOL AUTOMATION

Since 1910

New line of Cam-Operated Basic Indexing Units



Size & Model	Positions	Dial Plates	Tool Plates
STA9 B	8 12 16 20 24	18 to 30 inches	36 to 42 inches
STA9 C	16 20 24 32 36	30 to 42 inches	42 to 54 inches
STA9 D	24 32 36 40 48	42 to 54 inches	48 to 66 inches

All these units can be supplied with or without a 10, 20, or 40-1 integral reduction unit. Can also be supplied with 90°, 120°, 180° or 270° cams. Stationary center column available if required.

The great demand for the smaller Model STA9-A basic indexing unit has resulted in an expansion of the Standard Tool basic indexing line. The addition of the Model STA9-B, C, & D makes it possible for you to adapt at least one of these units to your present plans for automation. Please submit your problem for a complete engineering proposal.

Illustrated literature describing Standard Tool Indexing Units —the basis for Automation— available on request.

STANDARD TOOL AND MANUFACTURING CO.

Creative Machine Designers and Builders

245 LAUREL AVENUE

KEARNY, NEW JERSEY

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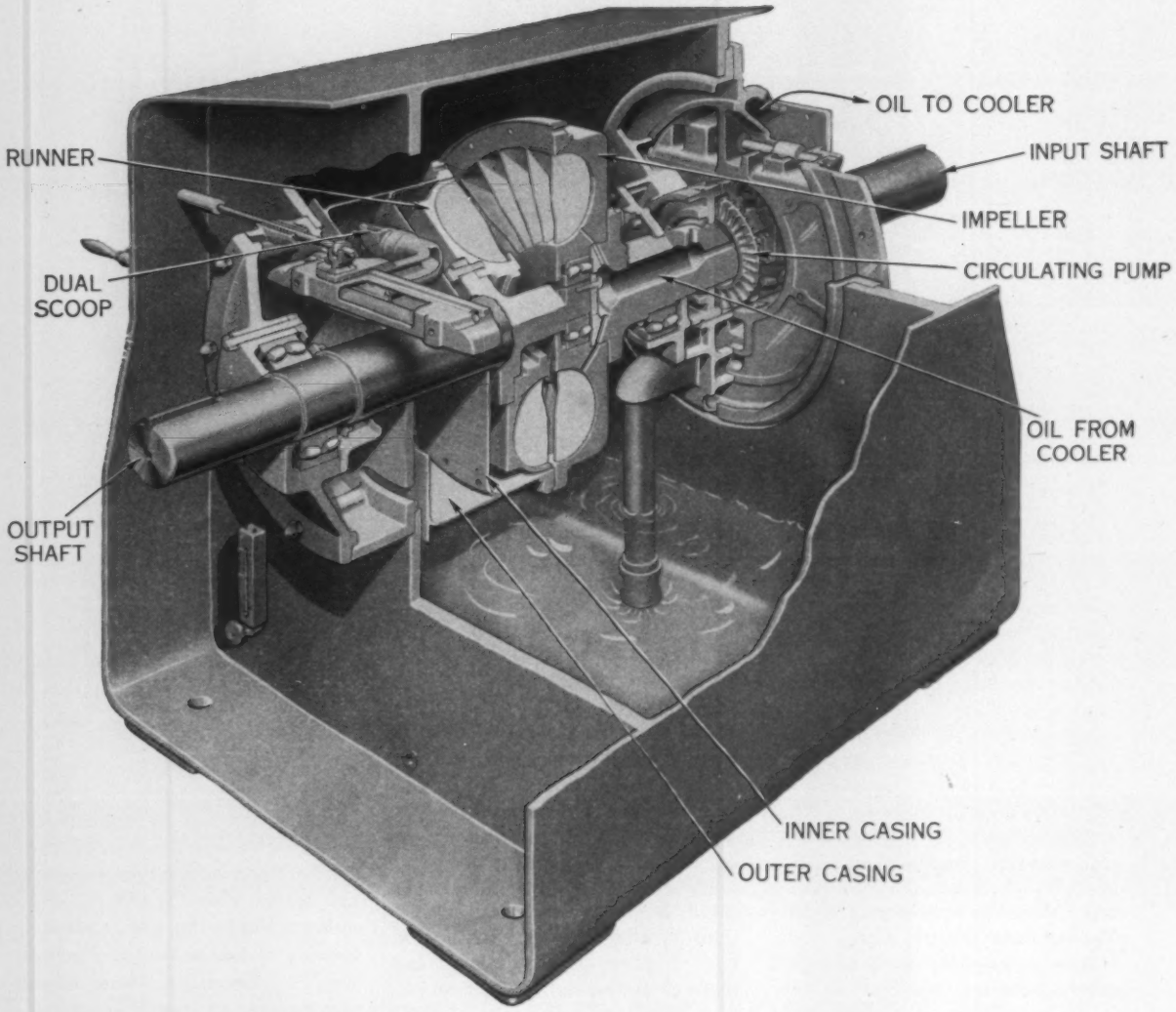
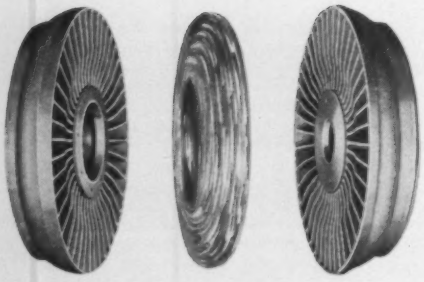
Now! More than through *GÝROL*® Fluid





Type VS, Class 2 Gýrol Fluid Drive—in sizes from 1 to 800 hp—adapts to automatic or manual control, has no mechanical connections between driving and driven shafts to cause friction-wear.

Using a vortex of oil to transmit power, Gýrol units provide simplicity of design, quietness, and flexibility offered by no other method of power transmission.

4,000,000 hp driven Drive . . . Here's why:

1 No-load starting—Gýrol Fluid Drive simplifies starting equipment because it permits the motor to reach operating speed before engaging the driven machine. Result: Motor can in many cases be selected for the running load—over-motoring for hard-to-start loads can usually be avoided.

2 Smooth, easy starting—Gýrol Fluid Drive provides infinite speed adjustments—accelerates loads without steps or bumps.

3 Controlled acceleration—Adjustable-speed Gýrol Fluid Drive allows fully controlled rate of acceleration—as slow or as rapid as required for specific processes, and to prevent overloading the motor.

4 Clutch and declutch action—Adjustable-speed Gýrol Fluid Drives have the ability to essentially declutch motors from their loads. When synchronous motors are used, the improvement in power factor can be gained at all times whether or not the driven machine is in operation.

5 Stepless, adjustable speed—Gýrol Fluid Drive's smooth, stepless speed control over the entire operating range makes it possible to run the driven machine at the exact speed required.

6 Isolation of torsionals—A Gýrol Fluid Drive transmits power through a cushion of oil with no mechanical connection. Shocks and torsional vibrations, originating from either driving or driven equipment, are isolated.

7 Limit against overload—Gýrol Fluid Drive has a definite maximum torque-transmitting capacity—governed by oil-fill size and input speed—which serves to protect both motor and driven machine against excessive overload.

8 Braking—Because Gýrol Fluid Drive can operate with input and output members rotating in different directions, dynamic braking for either intermittent or continuous duty is possible. Two proved applications: rapid deceleration of high WR^2 loads, and continual braking of paper unwinder rolls.

9 Minimum maintenance—Gýrol Fluid Drive has no mechanical connection between driving and driven shafts—no friction devices such as belts, clutches or sheaves to wear—no vacuum tubes, slip rings, brushes, or other electrical components to break or fail. Its non-wearing power-transmission medium—a vortex of oil—provides extra-long service life.

10 Wear or erosion reduction—On pumps, fans, or compressors, adjustable-speed Gýrol Fluid Drive permits lower average speeds than throttle-control with dampers or valves—greatly reduces erosion caused by particles in the air or liquid handled.

11 Reversible operation—All constant-speed and some adjustable-speed Gýrol Fluid Drives are completely reversible by reversing the motor—give identical performance in either direction of rotation.

12 Power savings—By providing stepless speed control without wasteful throttling, Gýrol Fluid Drive cuts horsepower consumption on centrifugal machines such as fans, compressors or pumps.

Thousands of industrial-drive applications have *proved* the advantages of American Blower Gýrol Fluid Drive in cutting power, equipment and maintenance costs. It answers virtually every power-transmission need involving adjustable-speed drive.

Send this coupon today for full details on the Type VS, Class 2 Gýrol Fluid Drive featured here . . . and other types that handle up to 12,000 hp. Or contact one of our 73 branch offices direct. American-Standard,* American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

AMERICAN-Standard
AMERICAN BLOWER DIVISION

*American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation.

American-Standard, American Blower Division,
Gýrol Fluid Drive Dept. 12-108, Detroit 32, Mich.

Please send full details on Gýrol Fluid Drive for the following application:

Name

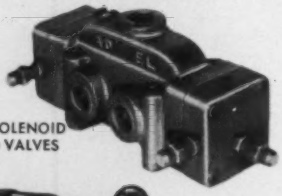
Title

Firm

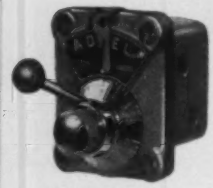
City and Zone State

ADEL *Reliability in Your Hydraulic Systems*

BETTER MACHINE CONTROL...
FOR BETTER MACHINE PERFORMANCE

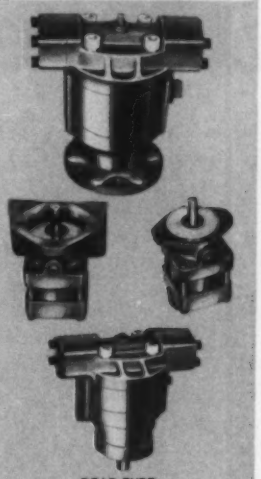


PILOT OR SOLENOID OPERATED VALVES



VOLUME (FLOW) CONTROL VALVES

DIRECTIONAL CONTROL VALVES



GEAR-TYPE HYDRAULIC PUMPS

New Industrial Gear Type Hydraulic Pumps with capacities from ¼ to 35 GPM at pressures to 1500 PSI and speeds to 3600 RPM.

The diagrams show but two of innumerable circuits and systems where these versatile pumps and control valves can be used to advantage.

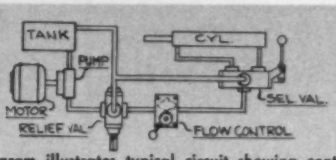


Diagram illustrates typical circuit showing control of cylinder.

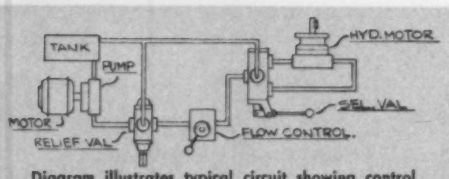


Diagram illustrates typical circuit showing control of hydraulic motor.

For metal working machines, industrial equipment, farm machinery, construction equipment, motor vehicles and marine applications... *Specify* ADEL *Precision-Engineered Hydraulics* for every mechanical operation in every industry.

Complete engineering specifications are available upon request.

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Industrial Air & Hydraulic Equipment Company
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Ray Bobbs Air-Draulics Inc.
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PENNSYLVANIA
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P. O. Box 11527, Pittsburgh 38

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WASHINGTON
Ray Bobbs Air-Draulics Inc., Seattle

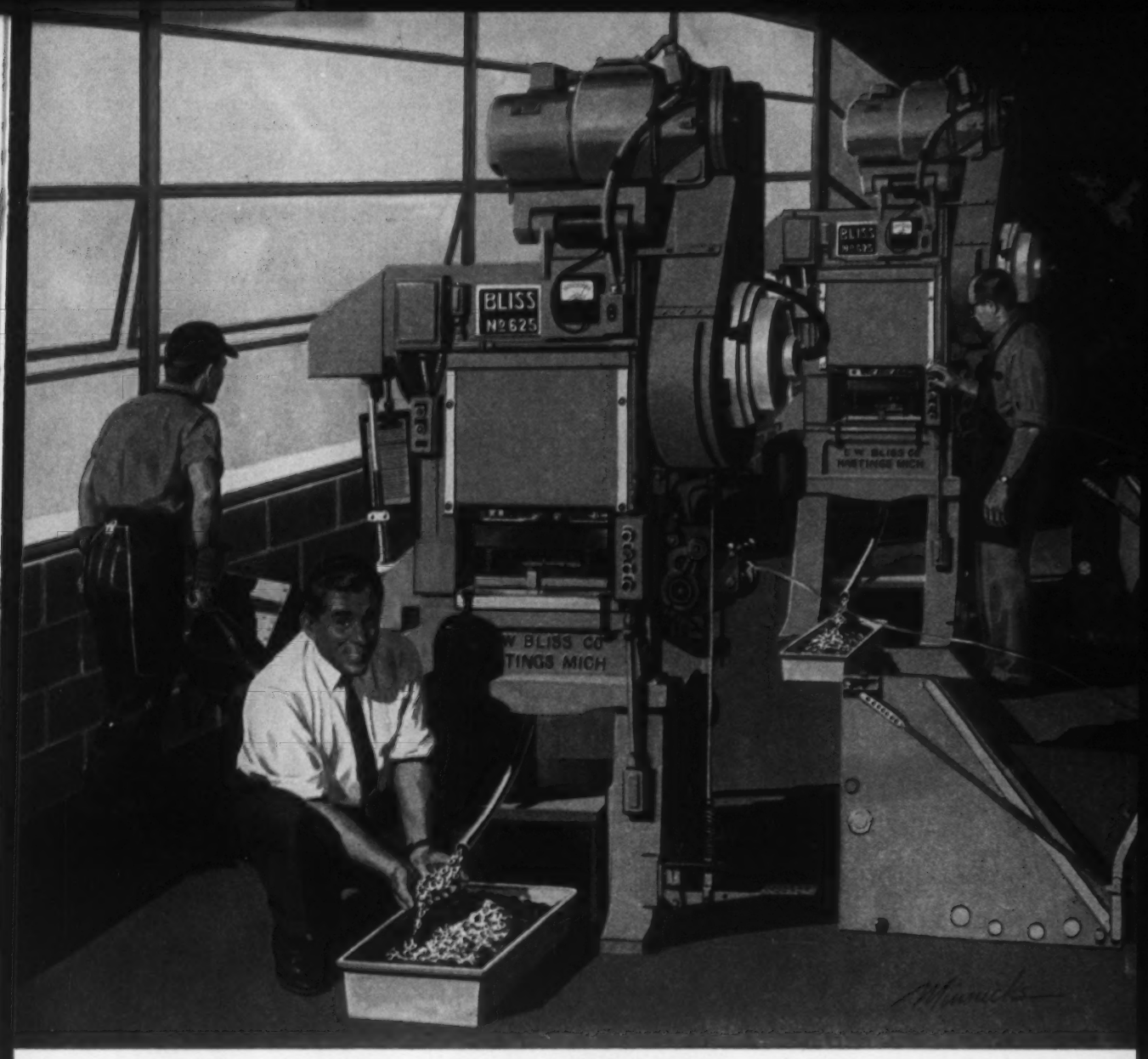
WISCONSIN
Neff Engineering Company
5856 N. Port Washington Rd.
Milwaukee 17

Circle 665 on Page 141

nished depends upon the inner and outer diameters specified. This varies from 3000 feet of 0.004 inch ID tubing to 500 feet of 0.040 inch ID tubing. If specified, the capillary tubing is thoroughly tested for rate of flow of gas through it. Long lengths of tubing can be used to connect remotely located sensing elements to indicating, recording, or controlling section of instruments. . . . *Copper shielded zippertubing* is offered by Zippertubing Co. For regular RF shielding, either copper or an aluminum foil is laminated to a vinyl saturated fiberglas to provide grounding of RF and UHF interference. The shielded jacket can then be closed around wires and cables by means of a plastic or metal zipper track. Other shielded constructions are available for protection against magnetic fields and nuclear radiation.

SPOTLIGHTING PLANTS

Sahlin Engineering Co. Inc. has increased its Birmingham, Mich., plant area for use in the development of new products and special automation machinery. . . . **National Forge Co.** is the new name of the National Forge & Ordnance Co., manufacturer of diesel engine and gas compressor parts, molds for cast iron pipe, aircraft and missile parts, and heavy machinery components for many industries . . . **A. Kimball Co.**, manufacturer of marking machine systems and punch-tag marking machines used in integrated data processing systems, has consolidated its main offices and production facilities in a new building in Brooklyn, N. Y. . . . **Air Logistics Corp.** has acquired Polaris Engineering as a subsidiary and has renamed it Metrolog Corp. The new company will engage in the development and manufacture of electronic instrumentation and specialized components for automation and automatic control systems. . . . **Hyster Co.** has started production of lift trucks in a new 100,000 sq ft plant at Danville, Ill. The plant features a highly mechanized assembly line for industrial lift trucks, a mechanized shipping department, and modern facilities for parts receiving, handling, and storage. . . . **Baker Bros. Inc.**, manufacturer of metalworking machinery, has purchased the Detroit Screwmatic 750



"I get 1200 parts a minute from each of these presses...

...all day long!" And production like that continues day in, day out. For Bliss High Production presses are especially designed for continuous high speed operation. Counterbalanced shaft, massive tie rod frame... square gibbing...features like these add up to *enduring* speed. For ease of operation there's ample room in front and back for die setting and space *under* the press for tote boxes or stacking chutes. Naturally, if you use large quantities of stampings this is the press that makes them. You will, however, be surprised to learn, that H-P presses can be set up so quickly and efficiently that more and more firms are using them for short run work.

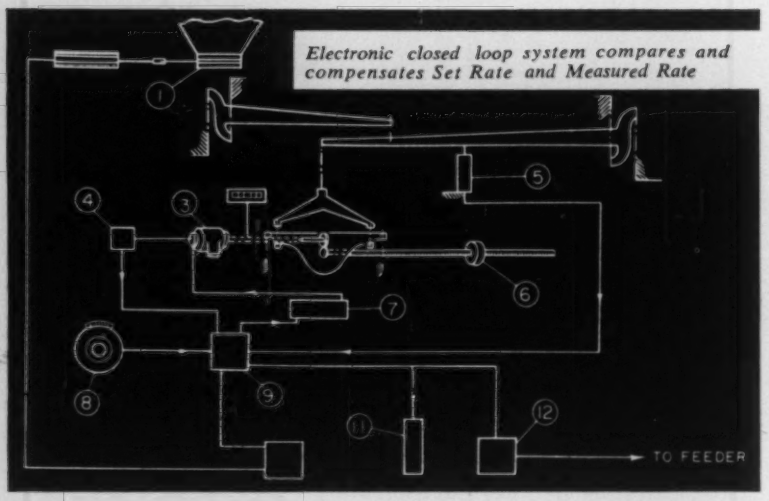
BLISS
SINCE 1857

E. W. BLISS COMPANY · Canton, Ohio

BLISS is more than a name... it's a guarantee

PRESSES • ROLLING MILLS • ROLLS • DIE SETS • CAN MACHINERY • CONTRACT MFG.

Circle 666 on Page 141



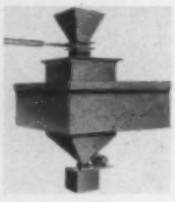
Electronic closed loop system compares and compensates Set Rate and Measured Rate

New Continuous Formulating System

Combines Thayer Scale's superior mechanical accuracy with the sensitivity of electronic compensating controls

Instantly responsive to 0.1% rate deviations in accuracy.

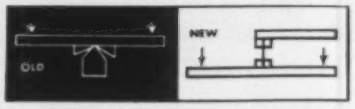
Thayer announces a radically new weight control system for processing hard-to-handle solids or liquids. This new loss-of-weight system provides rapid formulation with high sustained accuracy at rates up to 5 tons per hour.



Thayer Scale

A material hopper, (1) supported on a Thayer Flexure Plate Scale, is automatically filled to a selected weight and the scale is brought to balance by connecting a servo motor (3) and weight transducer (5) through a relay matrice (9). The poise (6) is then retracted, at a set rate (Dial 8), a potentiometer selects a voltage and a tachometer (4) measures the poise retraction rate. These variables are compared and differences are amplified (7) and sent to the servo motor maintaining zero error. The transducer senses deviations from balance and sends a signal to the controller (12) determining the rate of discharge. Should the system abort, an error circuit (11) will sound an alarm and interrupt the operation.

This closed loop system will maintain a constant speed control over long periods and its accuracy is not dependent upon wearing parts. The operation can be programmed by means of Thayer AUTOWEIGHTION Punch Cards. Indicators and recorders can be installed at remote locations.



THAYER FLEXURE PLATE LEVERAGE SYSTEMS are guaranteed to retain their accuracy for the life of the scale. Vulnerable knife-edge pivots are replaced by non-wearing Thayer Flexure Plates.* Neither dirt, shocks nor vibration can effect their accuracy. **Write Thayer about any problem you have controlling processes by weight.**

**Also utilized in Thayer Batching, Filling and Checkweighing Scales.*

THE Thayer SCALE

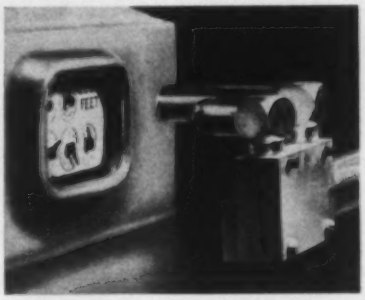
***THE THAYER SYSTEM OF PROCESS CONTROL BY WEIGHT**

AUTOWEIGHTION

THAYER SCALE CORP., 5 Thayer Park, Pembroke, Mass.

Circle 667 on Page 141

line from Gear Grinding Machine Co. Name of the machine will be changed to Baker Automatic Bar Machine. . . . **Epsco Inc.** has set up a new West Coast division, called Epsco-West, to design, produce, and market high-speed data processing and data control systems for military and commercial applications. . . . **Computer Equipment Corp.** is the new name of Digitron Inc. The company is engaged in the development of data storage techniques and other projects in the field of electronic computers and instrumentation.



DIAL ROTATION detector manufactured by ESS Instrument Co. actuates a signal each time a rotating pointer passes a predetermined point. Originally developed for a utility company to test gas meter accuracy, detector has a wide range of applications since it can be actuated by a very fine line or dot. Sensitivity of unit is increased by focusing lens for magnification of triggering line or pointer.

MEETINGS AND EVENTS

Oct. 13-15—

American Institute of Electrical Engineers. Tenth National Machine Tool Conference to be held at Statler Hilton Hotel, Hartford, Conn. Additional information is available from W. P. Carpenter, Superior Electric Co., 83 Laurel St., Bristol, Conn.

Oct. 13-15—

National Electronics Conference. Sponsored by AIEE, IRE, and several universities, conference to be held at Hotel Sherman, Chicago. Additional information is available from Art Streich, NEC, 84 E. Randolph St., Chicago 1, Ill.

Oct. 13-15—

Systems and Procedures Association. Eleventh Annual Interna-

Greenlee Transfer Machines can be Reworked to meet Product Changes

The Greenlee "Rearrangeable Unit" concept of transfer machine design is becoming increasingly popular in mass production manufacturing. These machines accommodate recurring changes in product design. Year after year they guard against costly obsolescence . . . they are changed to meet your changing requirements. Get the complete story from Greenlee.

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"LET ME TELL YOU ABOUT THE MOST STARTLING ADVANCE IN AIR VALVES IN 20 YEARS"

"It's our new 4-way Dual-Seal valve in ¼", ⅜" and ½" port sizes . . . and here's why it will outperform and outlast any valve on the market.

"*The valve tests at better than 40 million cycles.* Using our new spool-within-a-spool design, and the MACsolenoid, it operates at speeds that meet any known requirements . . . with shorter stroke, direct operation, lightning-fast response. And its circular-flow design actually increases rated capacities.

"*It is amazingly compact and light.* In fact, the entire valve is about the same size as *just the pilot* on most ⅜" valves—meaning a ⅔ savings in space and weight.

"*It costs you less!* Because the valve is design-engineered to standard manufacturing processes, and because it is more compact with fewer operating parts, we can pass along substantial savings in both single and double solenoid models.

"*The simple design reduces maintenance and increases production-line efficiency.* Out of a total of 11 parts, only 3 move . . . and the movement is so slight that failure due to fatigue is virtually nonexistent. The solenoid and cover detach in seconds without tools. For extra safety (and in conformance with J.I.C.) the valve is inoperative with the cover off. Exclusive integral conduit boxes connected by wiring channels permit optional wiring . . . save time and labor. And new plug-in wire lead connectors are now standard on all models . . . speed up installation.

"*Here's another innovation — add-a-unit manifold bases!* These individual manifolds let you group 2 to 10 valves. When combined, the bases form a single common inlet, common exhaust and common conduit channel . . . permit compact, completely flexible mounting.

"*Standardized and interchangeable bodies, bases, solenoids, too.* Only two valve body assemblies and one solenoid assembly embrace the entire range of sizes — single or double — from ¼" through 1¼".

"For further information, contact a MAC representative (listed at right) or write to me direct."

Walter D. Ludwig, President

MECHANICAL AIR CONTROLS, INC.
10030 Capital, Oak Park, Detroit 37, Michigan

MAC

Circle 669 on Page 141

PHONE YOUR NEARBY "MAC" REPRESENTATIVE FOR DATA AND DELIVERY

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SOUTH GATE—The Rucker Co., 4956 Firestone Blvd., LOrain 4-2521

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MIAMI SPRINGS—Aero Hardware & Supply Inc., 4301 Northwest 36th St., TUxedo 8-2414

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(**SOUTHERN**) Automation Aides, 1618 Willow Ave., Philadelphia 26, LaMott, Pennsylvania, MElrose 5-5555

NEW YORK
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NEW YORK 17—Machinery & Machine Supplies Co., Inc., 305 East 47th Street, PLaza 8-0744

OHIO
CINCINNATI 2—Fluid Power Engineering Co., 205 Keith Bldg., MAin 1-6640
CLEVELAND 9 (PARMA)—Fluid Power Engineering Co., 5451 Broadview Rd., FLorida 1-1199

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CANADA
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TORONTO—Trevor Babbs, National Time & Signal Co., 72 Shilton Rd., Agincourt, Ontario, OXford 1-4857

MECHANICAL AIR CONTROLS, INC.
DETROIT 37, MICHIGAN

MAC

tional Systems Meeting to be held at Penn - Sheraton Hotel, Pittsburgh. Further information is available from A. M. Motter, Jones & Laughlin Steel Corp., #3 Gateway Center, Pittsburgh 30, Pa.

Oct. 14-16—

Society of Industrial Packaging and Materials Handling Engineers. National Industrial Packaging, Handling, and Shipping Exposition to be held at the Coliseum, Chicago. Additional information is available from G. Cornwall Spencer, 327 S. LaSalle St., Chicago 4, Ill.

Oct. 16-17—

National Conference on Industrial Hydraulics. Sponsored by Illinois Institute of Technology and the Armour Research Foundation, fourteenth annual conference to be held at Hotel Sherman, Chicago. Further information is available from Raymond D. Meade, Illinois Institute of Technology, 3300 S. Federal St., Chicago 16, Ill.

Oct. 20-22 —

American Management Association. Orientation Seminar on Materials Handling and Work Flow For Job Lot Production to be held at the Carter Hotel, Cleveland. Further information may be obtained from Seminar Registration, AMA Headquarters, 1515 Broadway, New York 36, N. Y.

Oct. 23-25—

National Society of Professional Engineers. Fall meeting to be held at the St. Francis Hotel, San Francisco. Additional information is available from Kenneth E. Trombley, NSPE headquarters, 2029 K St. N.W., Washington 6, D. C.

Oct. 29-30—

Armour Research Foundation. Fifth Annual Computer Applications Symposium to be held at the Morrison Hotel, Chicago. Further information is available from Dr. Frederick Bock, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Nov. 3-7—

The American University. Fifth Institute on Electronics in Management to be held at the American University, Washington, D. C. Additional information is available from Lowell H. Hattery, American University, 1901 F St. N.W., Washington 6, D. C.

Nov. 5-9—

National Tool & Die Manufacturers Association. Annual convention to be held at the Sheraton Hotel, Philadelphia. Further information is available from George S. Eaton, NTDMA headquarters, 907 Public Square Bldg., Cleveland 13, Ohio.

Nov. 10-13—

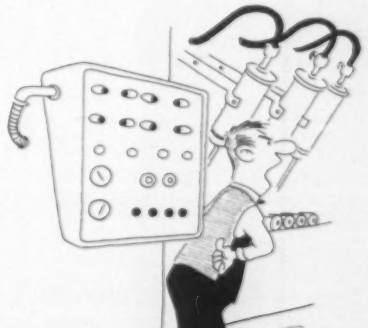
National Electrical Manufacturers Association. Annual meeting to be held at the Traymore Hotel, Atlantic City. Additional information is available from Joseph F. Miller, NEMA headquarters, 155 E. 44th St., New York 17, N. Y.

Nov. 17-21—

Society of the Plastics Industry Inc. Eighth National Plastics Exposition and Conference to be held at the International Amphitheatre, Chicago. Further information is available from William T. Cruse, SPI headquarters, 250 Park Ave., New York 17, N. Y.

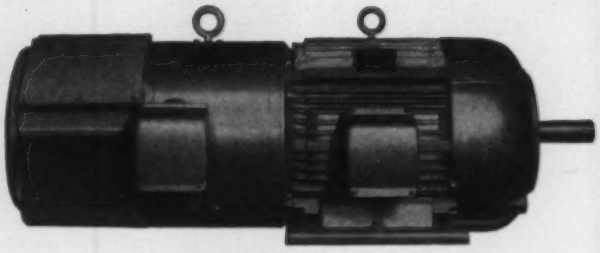
Nov. 19-20—

Northeast Electronics Research and Engineering Meetings. Sponsored jointly by the Boston, Connecticut, and Western Massachusetts sections of the Institute of Radio Engineers, meeting to be held at Mechanics Hall, Boston. Additional information is available from R. R. Leonard, Minneapolis-Honeywell Regulator Co., Newton Highlands, Mass.

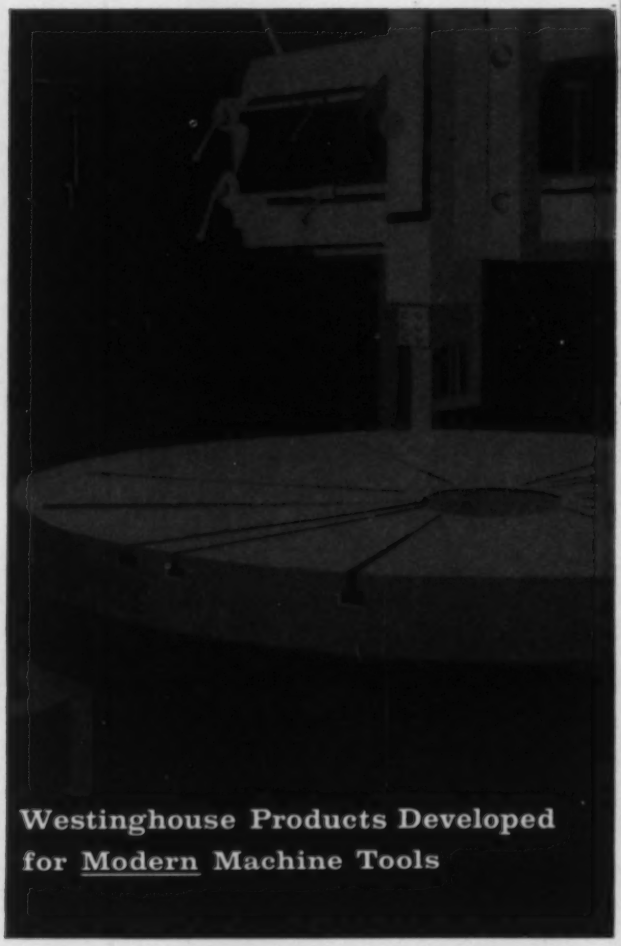


"O.K. now, which one of you electricians is the wise guy!"

NEW WESTINGHOUSE RECTIFLOW DRIVE



SINGLE, COMPACT UNIT PERMITS ADJUSTABLE SPEEDS DIRECT FROM A-C POWER SOURCE



Westinghouse Products Developed for Modern Machine Tools

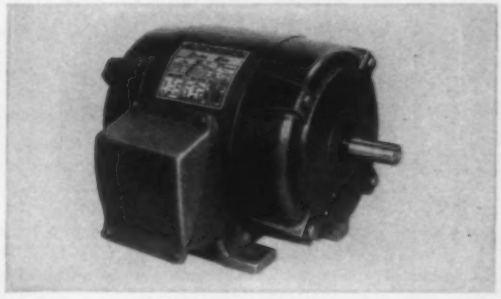
The new Westinghouse Rectiflow* drive gives performance direct from an a-c power source, which was previously obtainable only from a constant-voltage d-c motor with field control.

Completely electrical in a low-maintenance integral unit, Rectiflow is available in constant hp or constant torque, with inherent speed regulation no load to full load of 5 to 10 percent.

Available in TEFC, forced ventilated and dripproof construction, Rectiflow is another example of a Westinghouse product, designed to give the most production at the lowest cost.

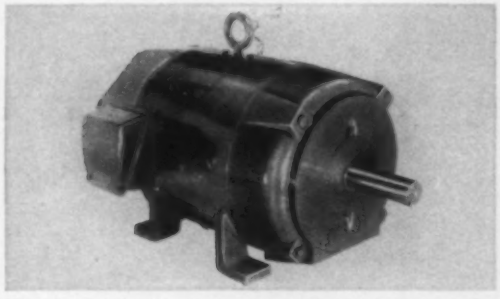
For complete information about Rectiflow drives — and other modern Westinghouse components, ask your Westinghouse Sales Engineer. Or, write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania. J-96111

*Trade-Mark



The reliable Westinghouse Life-Line® "A" a-c motor, part of Rectiflow, combines Bondar®, Bondite and Mylar* insulation for long life. Prelubricated, factory-sealed bearings eliminate need for lubrication — keep lubricants in, dirt out.

*DuPont registered trade-mark



The new Westinghouse Life-Line "H" d-c motor, with revolutionary silicone insulation, gives ten times longer insulation life. New compact design gives fastest response of anv industrial motor. New modern housing gives top protection and appearance.

YOU CAN BE SURE... IF IT'S

Westinghouse

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Valvair manual valves

. . . unlimited combinations using standard components!

Just like dialing your phone. That's how easy it is to select the combination of Valvair standard end and body sections *exactly* suited to your special manual valve requirements.
There's no need to endure complicated parts inventory, delivery delays and the other headaches connected with special modifications of ordinary manual valves. Not when you can get just what you need, using Valvair *standard* components. Ask your nearby Valvair representative to show you how! Want a Valvair manual valve selector? Write to Valvair Corporation, 454 Morgan Ave., Akron 11, Ohio.
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Compare and you'll buy

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Immediate delivery from local stock

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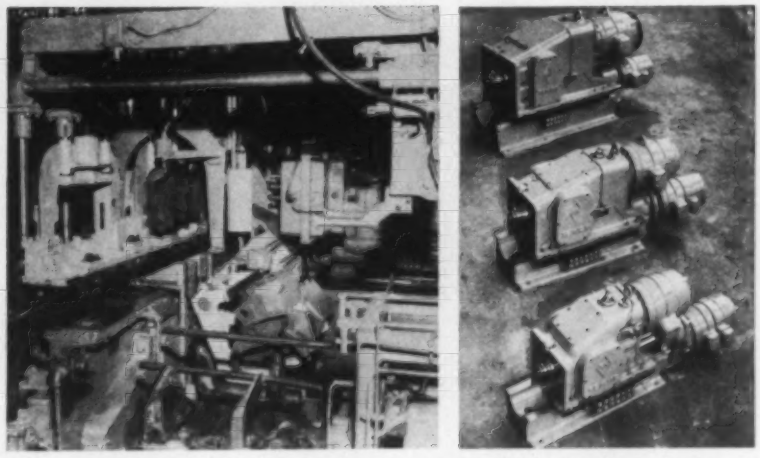
By JAMES C. KEEBLER Managing Editor



Closeup of reorienting station of transfer machine for cylinder blocks of the Paris-built Renault Dauphine. Such machines use heads of "building-block" design which are made in three capacity ratings by Renault.

Small Car Automation

EVEN those of us who like our wagons long and low-slung must take note of the "small car." You don't have to have "pawked yaw caw in Hawvawd Yawd" to know that if your sales curves are looking downhill, while someone else's have shifted into climbing gear, there are odds that say you may have put your money on the wrong horsepower.

Who's Wrong?

This problem is a perplexing one and it has the Detroit planners in a bind. Isn't there an American folk song about a certain number of million Frenchmen who can't be wrong? American Motors' reports that in 1957 they sold 97,567 Ramblers while in 1958 the figure for the period Jan. 1 to Aug. 10 is 104,677. Any of the big three would like to be running that many units ahead of last year, instead of behind. In South Bend the whole town is said to be betting on the success of the new Studebaker small car.

Auto industry's 1958 sales may run 2 million units below the desired market. However, there's still no conclusive evidence to show that those 2 million who didn't sign a sales contract would have shelled out their shekels for a small car if each of the big three had offered same with the words "made in USA" inscribed thereon. Most of the learned prognosticators agree on at least one point: The reasons that kept so many customers home in droves are more complex than the lack of a small car in every showroom.

Foreign Appeal

There are endless ways to change the size and shape of motor vehicle design and still present four wheels to the pavement, but there's one thing that an American-made car can't be—made abroad. This feature alone seems to have a great appeal to a fair segment of the American driving public. How large that segment is still remains a big question mark.

Detroit had a banner year in '55, but for all we know the Europeans might have doubled their own performance here, if they had had the cars to sell. Increased (and increasing) production abroad can readily be interpreted as increasing competition in the U. S. marketplace. Those who are buying old-world charm and a foreign label may be lost beyond recall, but Detroit doesn't want to lose the guy who buys on the basis of dollar value. Thus the U. S. automakers can ill afford to rationalize away the entire trend as recession jitters. Sometimes the only way to find out "what the public would do if . . ." is to try them out and see. Surely there are more ways than one to appeal to the U. S. drivers' desire for a new jalopy.

It's Not Too Late . . .

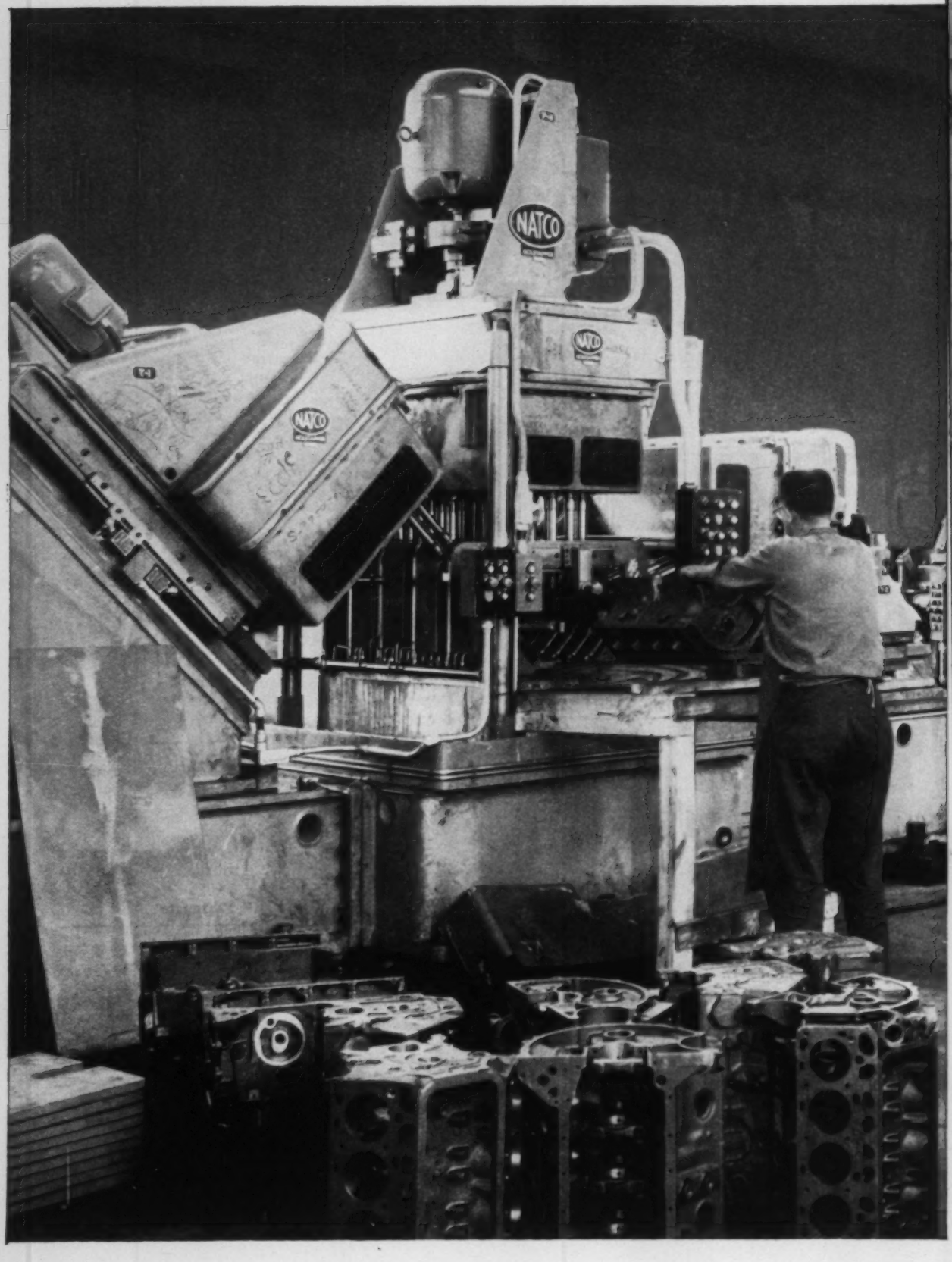
Considering this overseas competition from an automation standpoint brings up some interesting issues. When the machine tool builders went to Washington to cry about foreign competition the statements indicated that the Europeans are selling *standard* machine tools in the U. S. for less money than they can be made for here. Imports are up—exports are down. The big reason—low wage rates abroad.

On the *special* machine tool side of the ledger the story is different. Exports are up. Major U. S. machine tool builders are happily selling automated production equipment abroad. No major installations of foreign-built automated machine tools have been made in the U. S. The big reason—U. S. industry leads in automation technology and the Europeans are happy to buy the results of this leadership.

. . . to Automate

Looking at the automakers abroad it appears that they have not been asleep at the automation switch. As they have expanded production and built new factories they have gone automatic. This has been done not only with American-built automated equipment, but with machinery of their own design. If the U. S. machine tool industry is hurting now from hand-made European products competing in their market, how long will it be before the U. S. auto industry will be hurting from machine-made European products? In the long run, can an automated European

←Circle 671 on Page 141

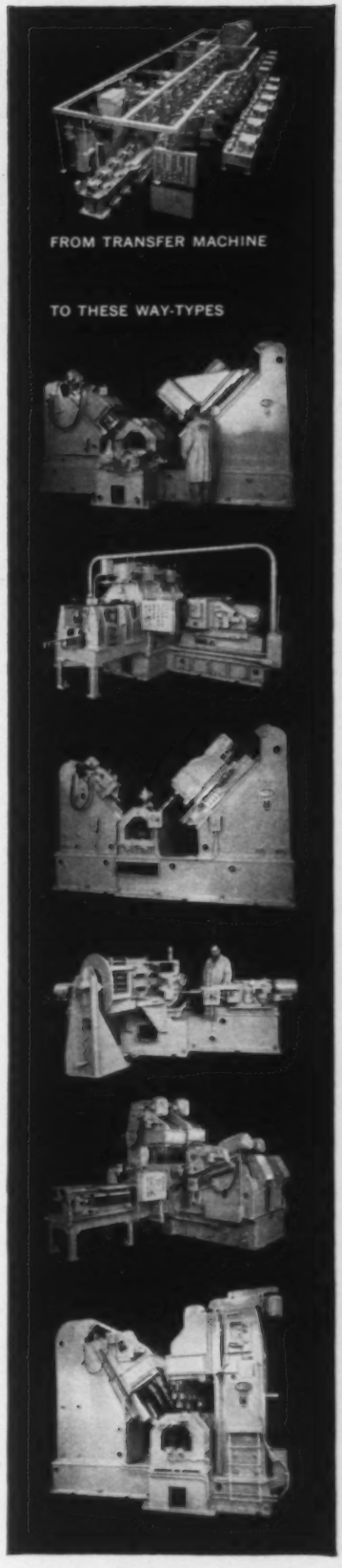

NATCO
NATCO
NATCO

Must your transfer machine go to scrap every time your model changes?

Certainly not. For example, the way-type machines shown here were once stations in an automated straight-line transfer machine. Now they will begin their second life as individual machines on a shorter-run lower-production assignment.

Each station in your Natco transfer machine—whether drilling, boring, milling, sawing or chamfering—is a machine tool in its own right. With modifications and new tooling, it may serve you for many years beyond its original "single-purpose" life.

When product changes call for new tooling, consider adapting the previous machinery to a new use—and realize substantial savings. Natco engineers and manufacturing facilities are at your disposal to make the necessary modifications. Call your nearby Natco representative today to discuss converting your equipment.



NATCO

Multiple-spindle drilling, boring, facing and tapping machines. Special machines for automatic production.

NATIONAL AUTOMATIC TOOL COMPANY, INC.

Dept. 294-N Richmond, Indiana

Natco offices in Chicago, Detroit, Buffalo, New York, Boston, Philadelphia, Cleveland and Los Angeles. Distributors in other cities.

Circle 672 on Page 141

auto factory offer greater dollar value of merchandise than can be offered by an automated auto factory in Detroit?

While it may not be good politics (or good diplomacy) to suggest that we stop exporting technology, it could hardly be said to be unpatriotic to suggest that the larger implications of these issues make good food for thought.

Paris Products

A case in point is Renault. Their publicity releases are very revealing. *We quote*:

"The Regie Nationale des Usines RENAULT is the largest French automobile manufacturer. Its main plant, located at Billancourt, close to Paris, has a staff of nearly 40,000 people and the most modern facilities for foundry, stamping, machining and assembling purposes. It was founded in 1898.

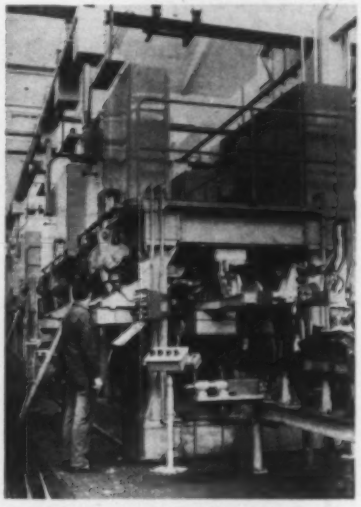
"Owned by the French Government since 1945, the RENAULT plant is controlled by dynamic methods successfully applied to free enterprise. Thus, although the plant was destroyed during the war, as well as other firms elsewhere in Europe, the Regie Nationale des Usines RENAULT has succeeded in securing a major position in the world automobile market, thanks to the tooling up and the modernization plans started during the last few years—without any help from the Government.

"As regards passenger cars, the Regie RENAULT conquered a wide experience in the field of manufacturing small piston displacement and rear engine cars. The '4 CV' has been very popular for long all over the world, and the 1,000,000th one will soon come out of assembly. The 'Dauphine',* last born product of the Regie, is already enjoying a world fame, thanks to the 270,000 samples which are running throughout the world. Among these, 200 cars are daily exported to the U. S. A., and this figure will soon be increased, as the success achieved by this car near the Americans is important.

"Machining is performed on numerous automatic operation machines which, in most cases, control their own cycle of operation. The most interesting of these machines incorporate a number of standardized units: the RENAULT electro-mechanical heads, designed and built at the very plant and which cover a range of three distinct power capacities although of identical design. These heads provide for all the conventional machining operations: boring, milling, drilling and tapping, and can be set to any position. Their relatively small size warrants the simultaneous use of several heads for one part being machined.

"Some of these machines further feature the automatical shifting of the parts from one station to the next one; they are called transfer-machines.

"Among the various transfer-machines as used at the Regie RENAULT, we will mention that which machines the engine cylinder-blocks; it performs 725 operations automatically, including 100 checking operations. It delivers one machined cylinder-block every 40 seconds.



Group of spotwelding machines used to automatically fabricate floors and frames of the Dauphine.

"Numerous French and foreign industries are now equipped with RENAULT transfer-machines, so that the Regie has become the 6th French machine-tool manufacturer.

"A new plant, erected in 1952 at Flins, in the Seine valley, about 25 miles downstream from Paris, is equipped with stamping and assembly facilities considered by many experts, both European and American, as one of the most up-to-date in the world.

"It was built up within a record-breaking time from September 1950 to January 1952, and a second set of works, which doubled the production capacity, was achieved in 1955/56.

"—At last—and that is the essential part of the FLINS plant—, the automation of its facilities has been developed to a very high level. Among these achievements may be particularly noticed the assembly lines of the Dauphine bodies with rail carriages fitted with an underground chain back-motion through pneumatic controlled lifts: electrical welding machines by multiple electrodes—for car floor welding—, which are also placed on rail carriages with underground back-motion; and stamping by sets of 8 to 10 presses working simultaneously, with automatic transport of the parts to be stamped from one press to another.

"—Experts in mechanical engineering have recently highly appraised the FLINS plant: Mr. DAVIS, Vice-President of the FORD-USA Corp. has especially declared to a Sub-Committee of the American Congress that this plant was more 'automatic' than any other in the United States.

"And Mr. NIKIFOROV, Vice-Minister of the Russian mechanical industry, said something similar during a radio-interview after his visit to Flins, a few months ago, when he had come to attend an 'automatics' Congress." *End of quote.*

Happy Ending

The biggest sales pitch that makes this car appeal to the poor Frenchman is that it's said to go 47 miles on a gallon of gas. Since gas is so expensive in France this is a powerful sales tool. On the other hand so few Frenchmen can afford the car (never-mind the gas) that Detroit's salvation may well lie in the power of the French labor movement. If wage rates can be upped to the point where the workers can afford two cars for every family, an international competitive labor balance can be established and price advantage will go to the best automater.

*Editor's note: In French history (1349 to 1830) *Dauphin* was the title of the eldest son of the King of France—*Dauphine* was the title of his wife.

ERIEZ MAGNETS In Automation

NEW IDEAS from Eriez

For fourteen years Eriez has specialized exclusively in the design, manufacture and sale of high quality permanent magnetic equipment for machinery and conveyor manufacturers, design engineers, contractors and direct users. Our unique knowledge in the field of magnetic design and application has developed through experience gained by working in hundreds of a wide variety of industrial problems.

Eriez does not design, build or sell material-handling systems, but we serve people who do in areas where magnetic equipment should be incorporated. We willingly share the design- and field-application know-how gained through helping others move materials faster, more economically, more efficiently, more accurately by utilizing the inherent advantages of magnetism. And, since our engineers work closely with both system manufacturer and ultimate user, the most efficient installation is the end result.

Specifically, we produce standard lines of magnetic equipment and, in addition, design and build special components to *magnetically* convey, transfer, control, elevate, re-position, hold or re-orient basic ferrous materials or finished parts. Result? . . . materials move faster, more economically, more efficiently, more accurately—with complete control. Eriez automation units increase production, while lowering production costs. More positive hold reduces damaged parts, improves safety conditions.

Let **ERIEZ** *solve your magnetic automation problem! We'll be glad to help you in your special automation needs. For information or assistance, contact your nearest Eriez representative, or write direct giving as much advance information as possible. No obligation, of course. Eriez Manufacturing Company, 119K Magnet Drive, Erie, Pennsylvania.*

Circle 673 on Page 141

Eriez Magnetic Units provide these important AUTOMATION ADVANTAGES

- First cost is the only cost
- Powerful, self-contained magnets are virtually trouble-free
- Magnetic strength is guaranteed indefinitely
- No electrical accessories or wiring necessary
- No power consumption; no operating costs
- Maintenance is virtually eliminated
- Less work space is needed
- Positive hold permits faster conveyor speeds
- Simple design, simple in function
- Rugged design and construction; few moving parts
- Choice of surface facings: hard or rubber coated for finished parts
- Easily installed on new or existing equipment
- Wide range of styles, sizes, magnetic strengths
- No special skills or training needed to control, operate or maintain these units.

ERIEZ—pioneers and world's largest producer of permanent non-electric magnetic equipment for industry, has three major product lines to serve you:

HI-POWR MAGNETIC SEPARATORS—to remove unwanted iron from processing lines, ferrous from non-ferrous materials and iron contamination from liquids.

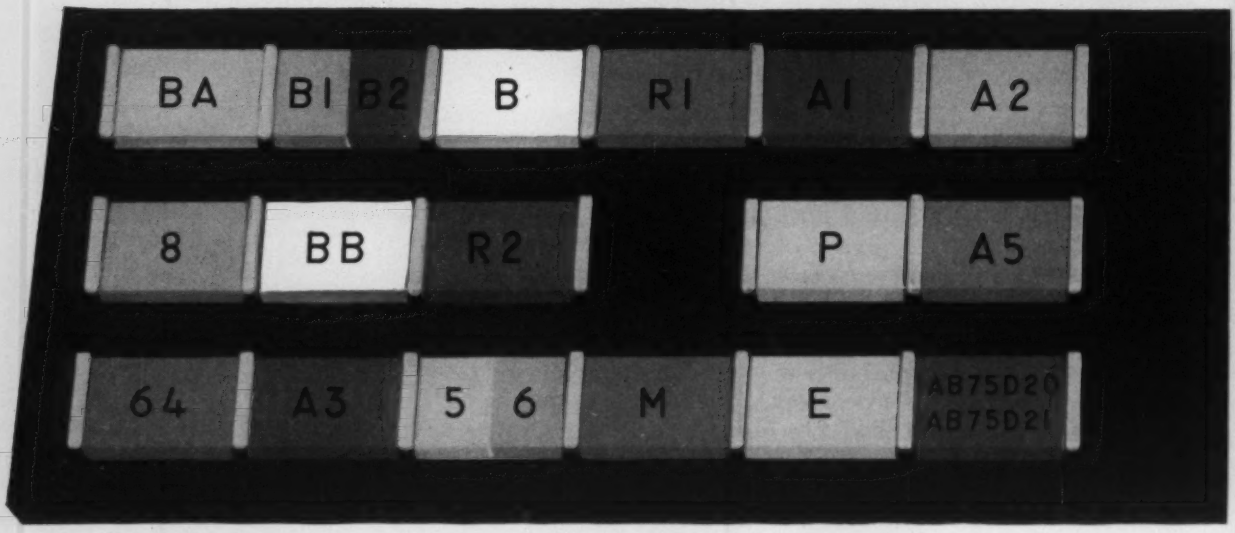
HI-POWR MAGNETIC AUTOMATION UNITS—to handle hundreds of materials-handling problems . . . to convey, control, transfer, elevate, re-position, etc., ferrous materials or parts during many manufacturing processes.

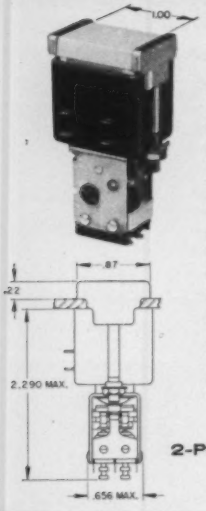
HI-VI VIBRATORY EQUIPMENT—to move and accurately feed bulk materials.

ERIEZ®

MICRO SWITCH Precision

These Lighted Pushbutton Switches Versatility . . . Flexibility





2-Pole Unit

"100PB3" Series
Maintained contact, alternate action operation. Each push of the button alternately transfers and restores the contacts of the two switches. The switches in this and other "100-PB" series assemblies are the "SM" subminiature.

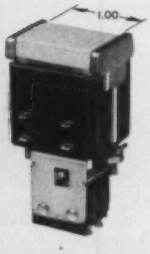
Designed For Computers, Business Machines, Electronic Data Processing Equipment, Scientific Instruments and Communication Systems

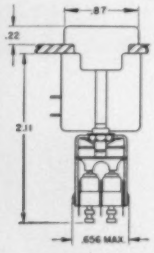
The above panel illustrates how the "100PB" series lighted pushbutton switches can be mounted in openings to accommodate one or more units, each button separated by assembly barriers.

The 1.00" x 0.75" translucent plastic buttons are available in red, yellow, blue, green or white—easily replaced or interchanged. Pushbutton, lamp, and switch are combined into a single assembly, thus reducing panel area to an absolute minimum. Lamp and switch terminals are isolated.

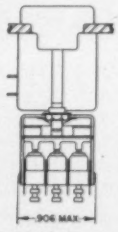
These switch assemblies and indicator lights simplify construction of panels, combine good appearance in minimum space. Each switch assembly contains two lamps for choice of lamp circuitry.

Switch assemblies, except "100PB3" series, are available with two, three, or four SPDT subminiature switches, rated at 5 amps 125

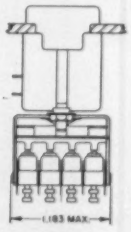




2-Pole Unit



3-Pole Unit

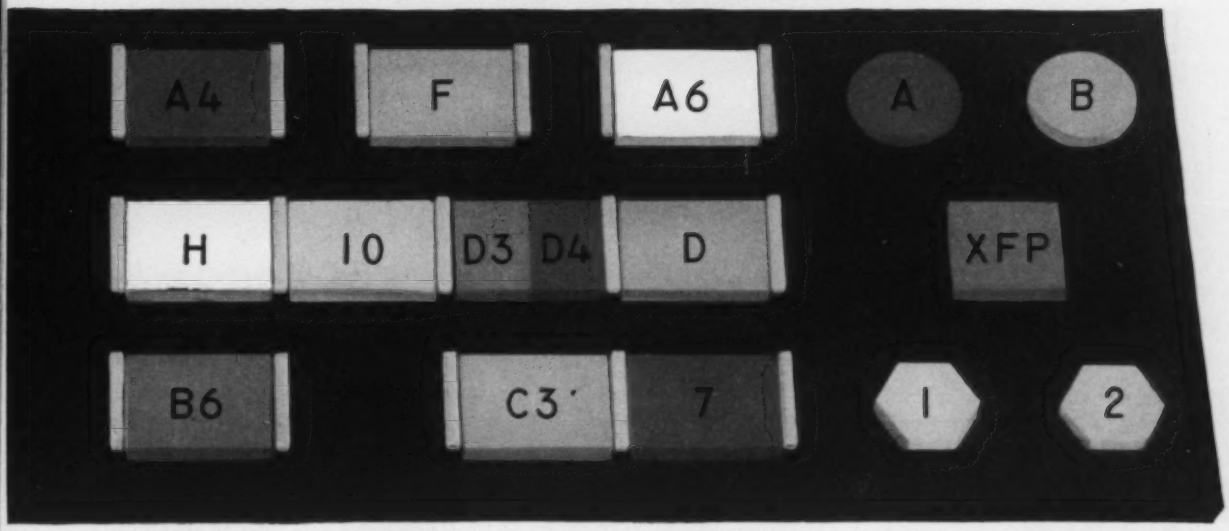


4-Pole Unit

"100PB1" Series
Momentary action—contact transfer only while button is depressed. Provides positive "touch feedback" or "feel" which reduces the chance of false operation. 2, 3, or 4-pole units are available.

Switches have uses unlimited

have--Eye Appeal . . .
. . . Require Less Panel Area



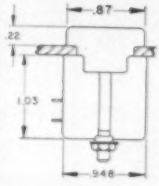
or 250 vac; or 3 amps inductive, 5 amps resistive, 30 vdc. *Send for Data Sheet 143.*

[The five buttons at the right of the main illustration are of the "50PB" series. Buttons of four shapes, in red, yellow, blue, green and white are available. *Send for Data Sheet 133.*]

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Ltd., Toronto 17, Ontario

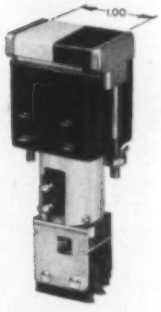
Consult with a MICRO SWITCH Sales Engineer.
Look in the Yellow Pages for location of Branch Office

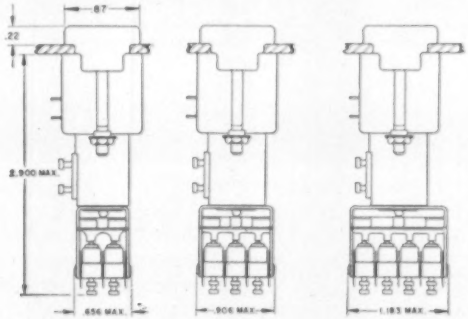
Honeywell
MICRO SWITCH PRECISION SWITCHES



"100LT1" Series
Matching indicating light assembly, without switch mechanism. Provides panel harmony. Has same button and lamp combinations, and same means of mounting as the complete switch assembly.

LT1 Indicating Light Assembly



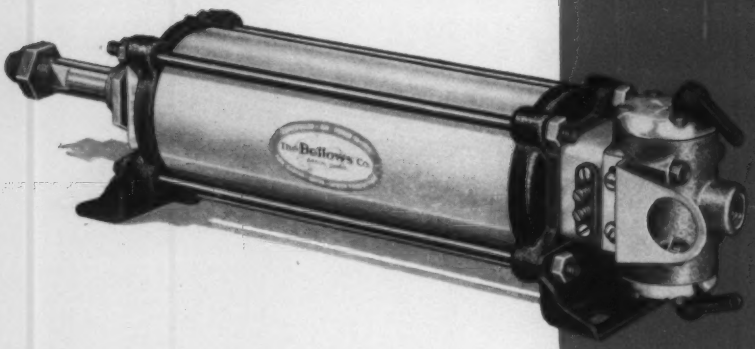


2-Pole Unit | 3-Pole Unit | 4-Pole Unit

"100PB4" Series
Magnetically held "MAGSWITCH" contains a d-c solenoid whose terminals are electrically isolated from the lamp and switch terminals. With solenoid not energized switch action is momentary; with solenoid energized switch contacts remain transferred until electrically released. 2, 3, or 4-pole units are available.

Circle 674 on Page 141

the ultimate in air cylinder power-



BUILT-IN ELECTRICALLY-CONTROLLED DIRECTIONAL VALVE

BUILT-IN DUAL SPEED CONTROLS

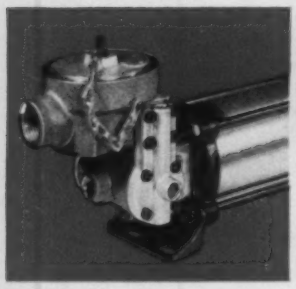
REQUIRES ONLY A SINGLE AIR CONNECTION

THE BELLOWS AIR MOTOR

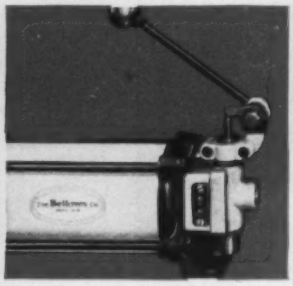
The Bellows Air Motor is a complete air cylinder power unit, with directional valve and speed controls built-in. Takes less than half the space and costs less installed than a conventional air cylinder set-up of equal power with its separate valving and piping. The single air connection, which can be made with flexible hose, makes it ideal for use on moving machine elements. It is a sturdy unit with forged steel heads, heavy brass cylinder, stainless steel piston rod. The piston rod is threaded, equipped with a wrench flat and nut. Many Bellows Air Motors have been operating day in and day out for fifteen years with negligible maintenance. And if service needs do arise, there is a Bellows Field engineer as near as your phone.

The Bellows Air Motor shown above is a 2½" bore unit equipped with the Bellows Low-Voltage (8-12V) Electroaire Valve. Other bores available are 1¼", 1¾", 3⅝" and 4½". Any stroke length. Optional choice of built-in valves as shown below.

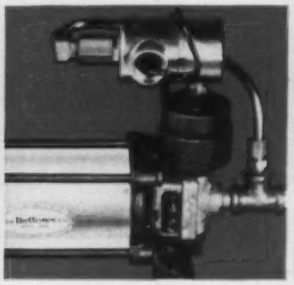
CHOICE OF BUILT-IN VALVES



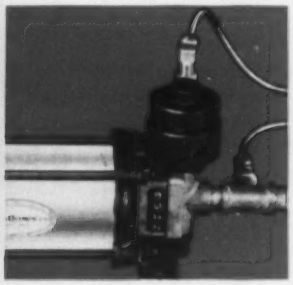
115 V. ELECTROAIRE VALVE
For J.I.C. applications where a 115 v. momentary contact is desirable.



MECHANICAL VALVE
For manual operation or for use with cams or direct linkage.



115 V. MAINTAINED CONTACT
Valve remains in shifted position during period current is applied.



AIR-OPERATED
For use in applications calling for full pneumatic control.

Write for these two booklets

Fifty pages of data to help you select the right Air Motor-Valve combination for your job. Address Dept. AU-1058, The Bellows Co., Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd., Toronto 18. Ask for Bulletins BM-25 and SP-55.

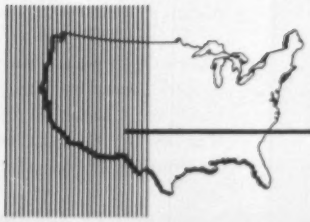
The Bellows Co.

DIVISION INTERNATIONAL BASIC ECONOMY CORPORATION

AKRON 9, OHIO

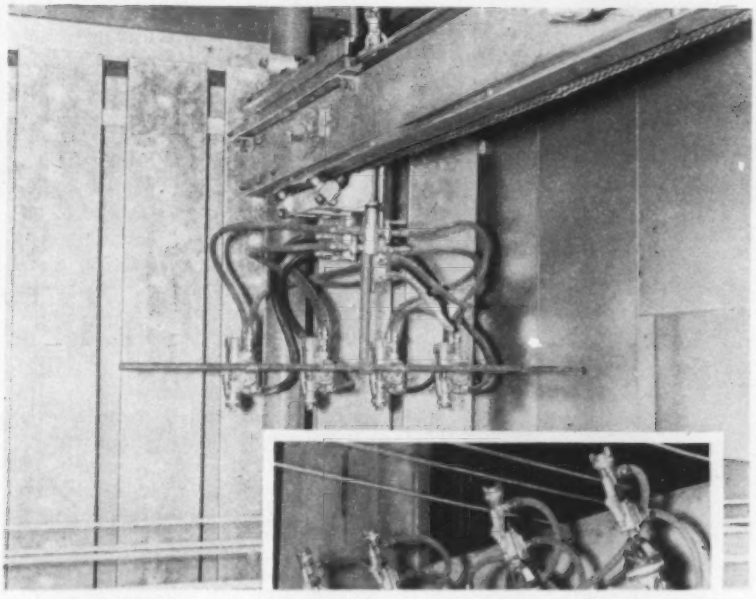
983-B

Circle 675 on Page 141



western roundup

By GILBERT C. CLOSE
Hawthorne, Calif.



Spray guns are used to apply enameling slip to aluminum architectural panels in a continuous production line at Vitri Finish Inc. Inset photo shows four fixed spray guns that spray underside of work as it passes above them on cable conveyor. Large photo shows spray guns which shuttle back and forth across the line of travel of the work in applying the enamel slip.

Aluminum Enameling Line

APPLICATION of porcelain enamel on aluminum was a dubious process a dozen years ago. It was being done, but usually in a small portion of the plant set aside from the main production line, and each process involved in the application was carried out with a "tongue in the cheek" attitude. Proper facilities were inadequate, and even if they had been available, a sure knowledge of how to use them was lacking. But the demand for porcelain enameled aluminum, especially in the architectural field, was too great to be frustrated by the lack of technical facilities and know-how.

Today, in the new plant of Vitri Finish Inc., City of Industry, Calif., the application of porcelain enamel on aluminum has shed its experimental status and has succumbed to automation. A continuous production line 140 ft long receives the aluminum from the pickling department, then turns it out beautifully enameled and ready for the architectural market. Human intervention during the actual enameling of the material is nil. The automatic controls on this new line are so precise that correct color matching is assured, even when portions of the same production order are fired at different times.

Currently three aluminum alloys, 3S, 61S, and 63S, are being enameled. The products include aluminum moldings, expanded metal sections for use as sunshades or decorative coverings, and large enameled aluminum panel sections used in curtain wall-type architectural construction. Many of the larger aluminum panels are of built-up, honeycomb-type, with the honeycomb sandwiches between two sheets of aluminum. These honeycomb panels are bonded together with thermosetting adhesive which makes them acceptable to the building codes established in most cities.

Production begins in the pickling room where the aluminum is cleaned and surface-treated. This is a rather conventional process except for the specialized solution employed.

The pickled sheets are then moved to the enameling line by fork lift truck or tow truck. Here they are loaded face up on an open-type conveyor consisting of five ½-inch steel cables running on grooved rollers. The open-type conveyor permits spraying of the under or backside of the panels without altering their position on the conveyor. After being loaded on the conveyor, the work passes progressively through two spray booths and a humidity chamber. It is then automatically transferred to a furnace conveyor.

The first spray booth contains an automatic transverse machine with four spray guns which shuttle back and forth across the work, applying the enamel slip. The shuttle stroke of this machine is adjustable up to 72 inches maximum. This same spray booth contains four fixed spray guns located beneath the cable conveyor and pointed upward. These spray guns apply the slip to the backside of the panels. The fixed guns, of course, are pre-adjusted on their mounting for the width of the work being enameled. The second spray booth contains another transverse machine with four spray guns for applying a second coating when, and if, necessary.

Beyond the spray booth, the conveyor carries the coated work through an 18-ft-long humidity chamber. Purpose of this humidity chamber is to keep the applied slip moist until it enters the fur-

APEX -authority on fastening

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TOOLS FOR screwdriving nut running FASTENING

nace. A pair of fog nozzles located at the entrance end of the humidity chamber project fog throughout its length. Keeping the slip uniformly moist on all panels until they enter the furnace is extremely important in obtaining accurate color matching.

The custom-built furnace used for firing the porcelain enamel coating is 40 ft long, and is heated by imported (France) infrared, quartz-type heating tubes which, in conjunction with the furnace instrumentation, maintain a constant burning temperature of 1000 F, plus-or-minus 5 F. This very close temperature control aids also in obtaining close color matching. The furnace will accept parts up to 60 inches wide and 20 inches high on its wire mesh, belt-type stainless steel conveyor. After leaving the furnace, the work is ready for shipment to the customer.

It is interesting to note that in this particular installation, one of the oldest arts known to mankind, that of applying a ceramic coating on a metal, is now being accomplished by one of the newest developments in industrial science—automation.

Relay Reliability . . .

In many automated installations, perfect operation depends largely on the sensitivity and infallibility of the relays used to control the various electrical circuits. Failure or imperfect operation of a single relay may cause a lot of trouble. This sort of annoyance may be drastically minimized by a new relay now being manufactured by the Leach Corp., Los Angeles, Calif., a long-time producer of precision relays and mobile power supply and control equipment. Leach recently announced the successful application of a digital computer to the design of electromagnetic relays vital to aircraft and missile performance. Marvin G. Nelson, chief engineer of the Leach relay division, points out that these same highly reliable relays can be used also in industrial installations.

The computer, Nelson says, makes possible the design of relays which are near perfect in reliability. It will resolve in a few moments design problems that no amount of engineering manpower could solve.

Circle 676 on Page 141

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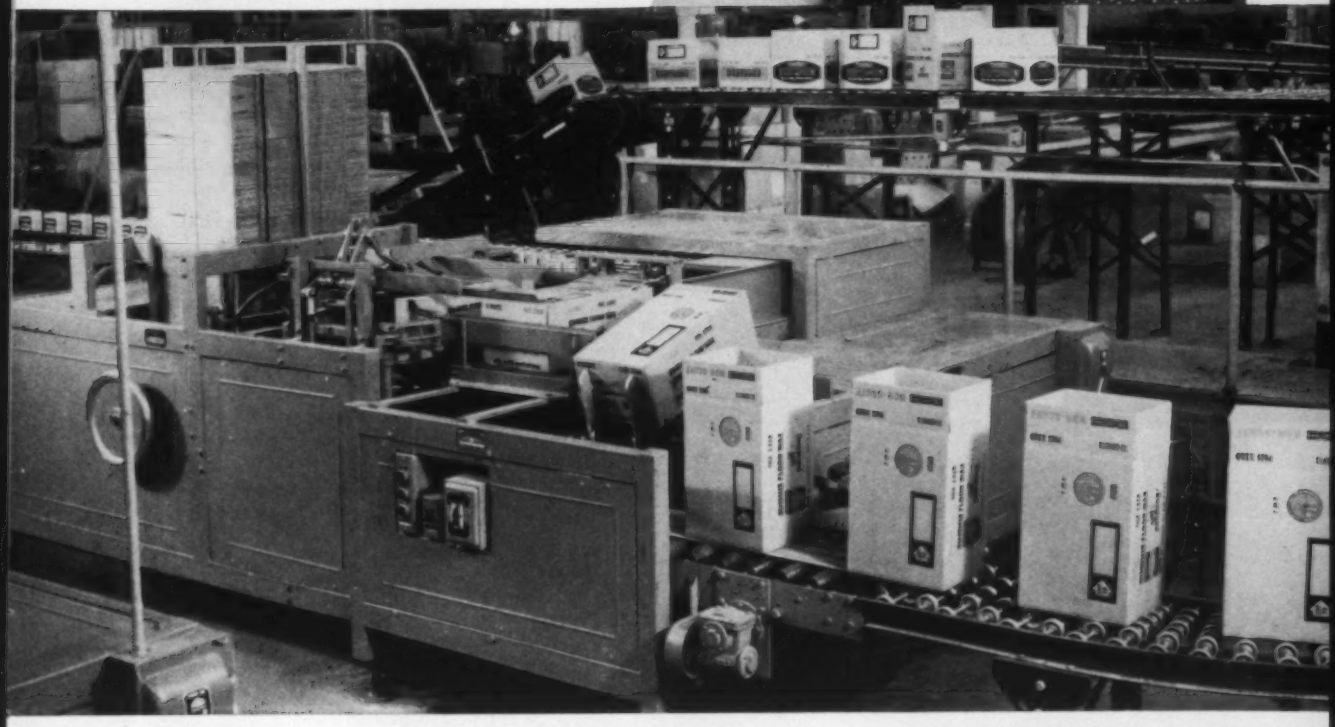

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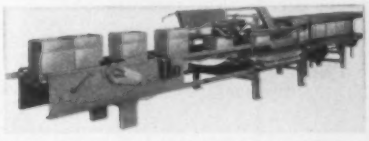

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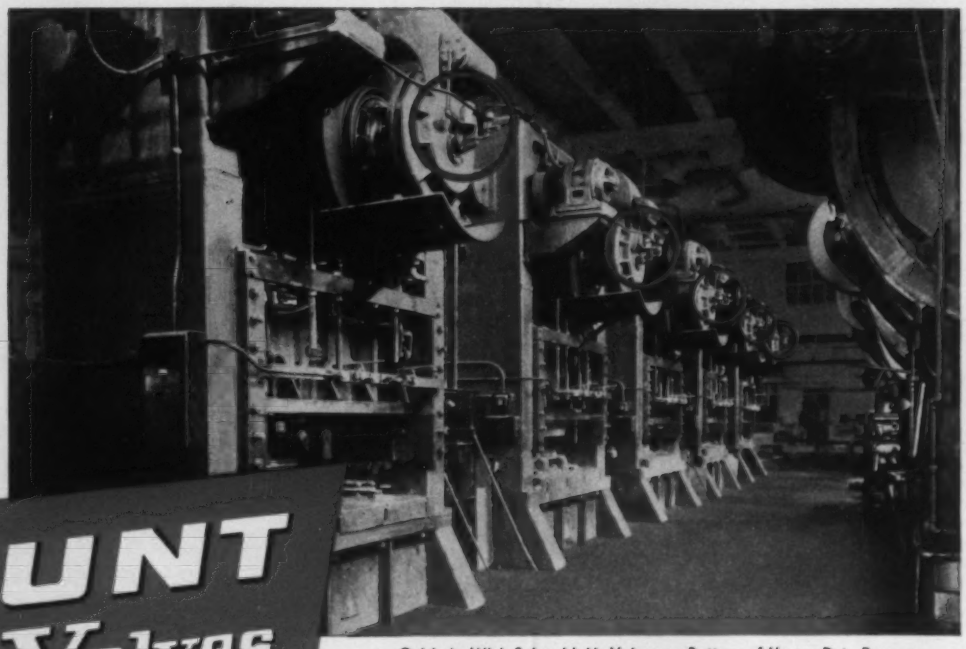

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Quick-As-Wink Valves on Tire Mold Handling Machine.

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That harsh sizzling noise you hear out in the plant, after the work force has gone home, is there during the day also. Only you can't hear it then. It's air, seeping out through inferior valves, wasting from $5.00 to $500.00 per month. And leaky valves mean sloppy machine control; danger of "repeating"; possible injury to the operator; or a breakdown involving costly repairs, material spoilage, lost production and customer ill-will.

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Circle 678 on Page 141

Savings or Losses

Significant today is the trend toward more and more "do-it-yourself" design of production machinery. Where new and unique manufacturing methods must be integrated into a complex automated system, there are often many obvious advantages to be noted in this course of action, considering the unpredictable complications that of necessity must be dealt with in achieving success. But there are also many pitfalls.

Often the do-it-yourself approach is entered into without full appreciation of the problems involved. To use this approach as a means of cost reduction on equipment is questionable unless careful study is made, especially where highly experienced specialists are readily available to supply the needed equipment.

Management must recognize that it may have a false sense of confidence in the do-it-yourself approach. Readiness to shift responsibility for complications, and to hide costs of installing and debugging may create an unwarranted impression of competence.

Many examples have come to light where blame for do-it-yourself projects that failed has been passed on to subcontractors or component suppliers. Where equipment is in-plant developed and designed, responsibility for final performance must necessarily rest with the designers. Here, proving out and adjustments are of key importance but, too often, plant management insists on overlooking line debugging with its very real cost. Where experienced engineers are concerned this cost is usually minimized, but it cannot be ignored.

Costs with new production equipment cannot be measured simply by initial investment, especially where in-plant costs are largely buried. In most instances costs can be held down and most effective performance guaranteed by centering responsibility in builders qualified by thorough experience to design and build complex equipment.

Manufacturing management has much at stake in such decisions. A careful evaluation will reveal the most suitable course of action and pinpoint realistic delegation of responsibility.

EDITOR

MANUFACTURING ENGINEERING . . .

. . . The functional organization for evaluating, planning and engineering for automatic production.

By **ROGER W. BOLZ,** Editor

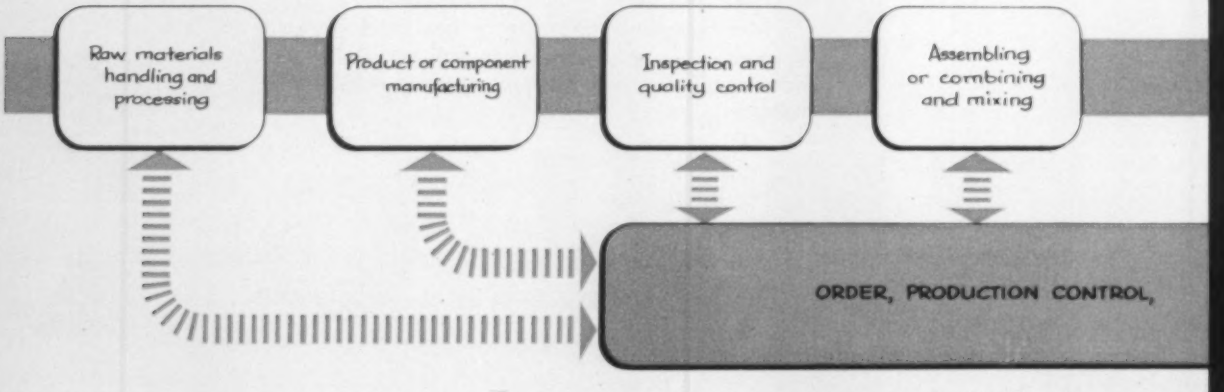
MANUFACTURING in the era of automation is no longer an art; it is fast becoming an engineering technology of broad, sweeping proportions. Truly, it can be said it has left the ranks of the shop man, the apprentice, the machinist, and millwright. To carry on competitive manufacture today requires an engineered approach, with full recognition that fundamental manufacturing problems are basic to all industries and eminently satisfactory solutions already exist for most all problems encountered; it takes broad knowledge and engineering acumen to achieve practical success.

To meet the challenge and need of the times, the broad new function of manufacturing engineering has evolved. Previously, no commonly found group in manufacturing organizations was in a position to serve so diverse and demanding a function. All other groups were already organized to serve specific needs; mostly of complementary significance but often too narrow in interest to achieve the aims.

In the past ten years the manufacturing engineering function has grown rapidly to take a prominent place in industry. Today, profitable operation depends on properly organizing this function: where there is no suitable organization the problems are many.

In manufacturing, the product produced is always a compromise between acceptable quality and acceptable cost. The seldom-reached goal is always one of maximum attainable quality for minimum possible cost. When the manufacturing engineering function is adequately recognized and properly implemented to fulfill its key part in the manufacturing cycle, amazing results are obtainable in terms of product quality and manufacturing economy.

Fundamental to manufacturing engineering is the fact that it encompasses thorough "before-the-fact" planning and detailed execution of the manufacturing process stages, not costly "after-the-fact" correction of poorly planned or unplanned operations. The


Raw materials handling and processing
Product or component manufacturing
Inspection and quality control
Assembling or combining and mixing
ORDER, PRODUCTION CONTROL,

Little heard of before the rise of automation, manufacturing engineering has today become a basic function in progressive manufacturing enterprise. Variously referred to as manufacturing engineering, production engineering, process engineering, automation engineering, industrial systems engineering or even master mechanic's department, this broad new function has become a necessity in developing effective and economical modern productive systems, regardless of the product or service involved. A wider knowledge of the fundamentals of the manufacturing engineering function should aid in the establishment of a sound economical management program for automation.

word "engineering" implies just that—a broad carefully engineered study and development of the overall processing system, including a study of product suitability for economic processing.

▶ The Rise of Manufacturing Engineering

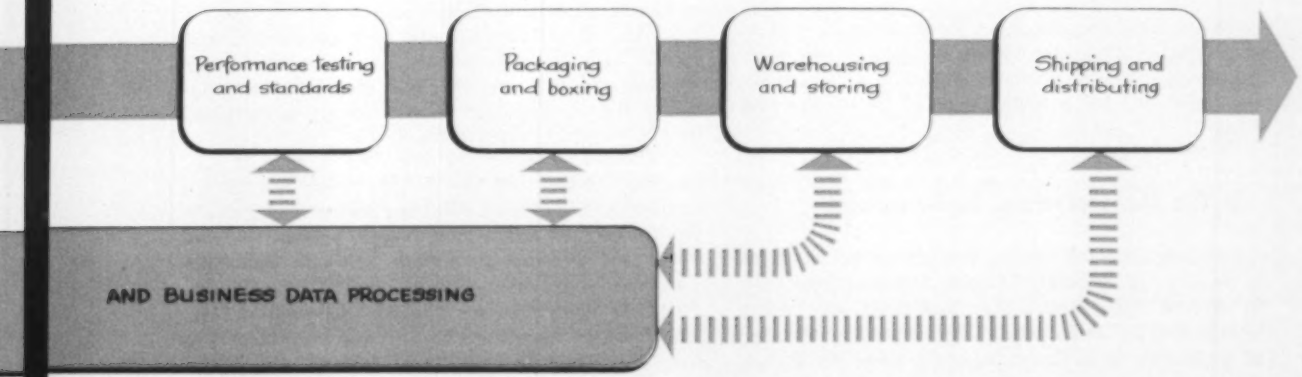
Probably most potent as a factor in the rapid evolution of the manufacturing engineering function was the rise of automation in productive systems. Conventional approach to manufacturing had always permitted considerable flexibility and considerable correction of poorly planned operations without incurring extremely excessive costs. Machines could be rearranged, production steps added, process cycles readjusted, or personnel added or removed. Today's more complex production systems and automated lines have proved, conclusively, this practice is no longer either satisfactory or economical in most areas of industry.

Authorities in the field agree that success of any manufacturer in maintaining or establishing a sound financial position in the competitive marketplace is based only partly on the design and development of new products. Of equal importance, success depends also on the ability and efficiency of the manufacturing engineering organization in producing the product to meet quality, volume, and cost standards that enhance the marketability of the product.

Basically, where market study reveals the demand, the product design engineer is called upon to create the desired product, using his ability to comprehend its end use and the conditions under which it must operate. His job is to plan, develop, assemble, and test one or more models or units meeting the desired product attributes. Once the product has been proved acceptable, process or production manufacturing engineers will determine the necessary kinds and design of production facilities to manufacture the desired product advantageously.

In every instance, the well engineered production system amortizes the investment in engineering time and creates added profits. The problem of manufacturing economics arises regardless of whether a new product is to be manufactured at a specific price, an existing process improved, or manufacturing costs reduced to meet competition. What are the right steps to be taken? Should more automatic operation be considered? How much automation will be economical and how sophisticated should the systems and processes be to produce the product? What are the right steps processwise? How do you get there with the right answers or processes in the shortest

Fig. 1—Eight basic steps involved in the manufacturing process. A selection or all of these steps must be coordinated by means of suitable information processing operations.



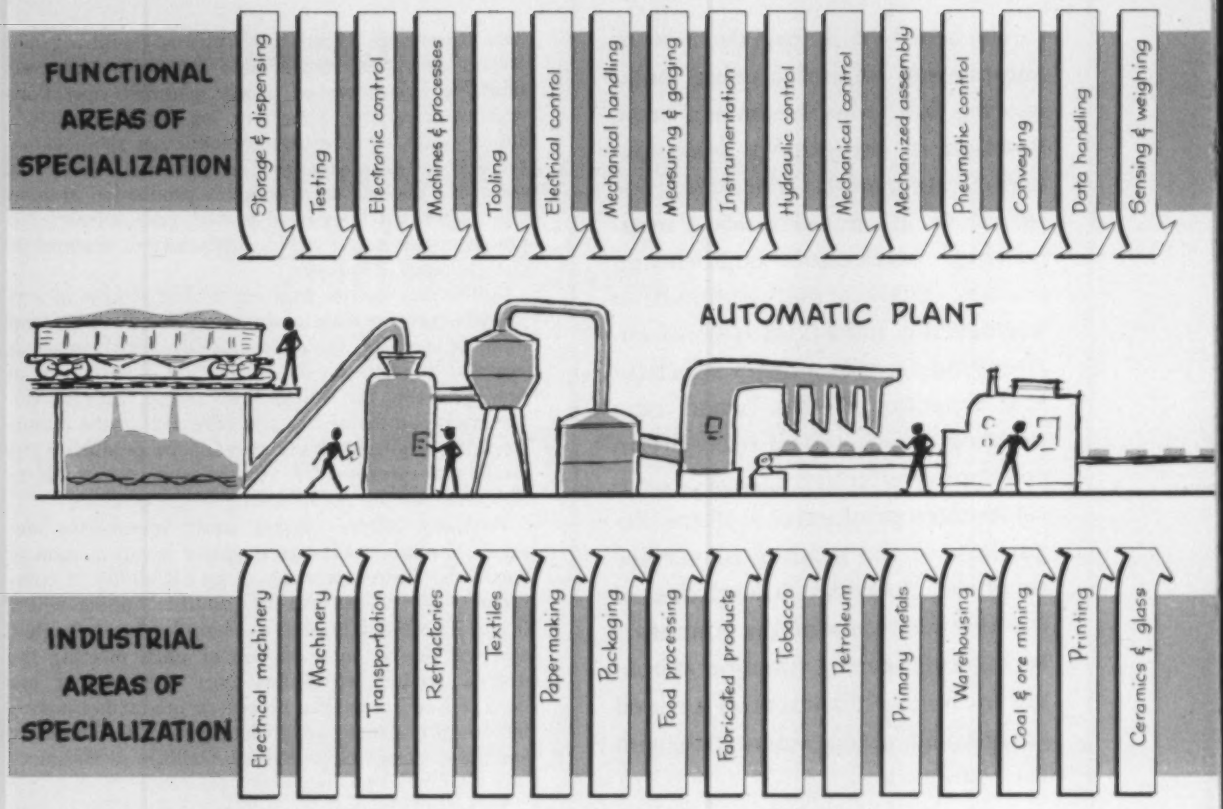


Fig. 2—Wide knowledge of operations, materials, and production methods are needed by the manufacturing engineer to achieve the proper combination and balance for successful automation.

period of time and with an adequate return for the dollars invested to get there?

Manufacturing engineering has evolved as the basic function to supply these answers today in industry. And, as industry becomes more diverse and products more complex, fulfilling this function calls for bringing into play the know-how from all facets of industrial enterprise. Tomorrow's effective solutions will result from crossbreeding of ideas from many areas.

The definition of manufacturing widely adopted and outlined in the Standard Industrial Classification Manual shows its broad scope: "Manufacturing is defined as the mechanical or chemical transformation of inorganic or organic substances into new products, including the assembly of component parts of products." Thus, the problems posed in engineering manufacturing processes that are economically successful call for a wide range of knowledge and talent.

▶ The Manufacturing Engineers' Job

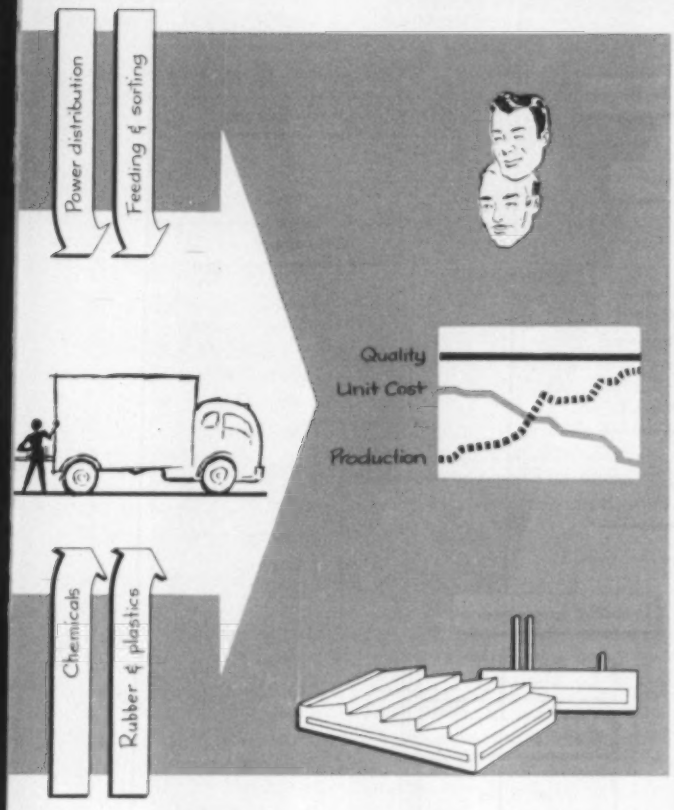
Basically, the job of the manufacturing engineer is to serve as a catalytic agent bringing into play in desired combination the necessary production techniques to manufacture the desired product—at acceptable costs. Actually, any process the manufacturing engineer brings into being cannot be considered a real success unless it fulfills the additional requirements that the 1. Product is made properly. 2. Processing is efficient. 3. Timing is right. 4. Operation is safe. These four requirements are all-important and, perhaps, could be labeled as basic tenets of manufacturing engineering.

1. A product that is made properly fulfills all the intended design considerations. It must function properly to suit the performance requirements specified and meet the quality standards needed for satisfactory operation. Quality in no instance can be anything less than that desired and, whenever possible, something considerably better, if it can be attained without objectionably increasing costs.

2. An efficient process not only provides manufacture at lowest possible cost consistent with creating the product properly, but also inherently includes the consideration of adaptability to increased output without adverse affect on costs.

3. Timing is important since the best, most economical product can be of little value if it is not available when needed. Without proper timing a new market may be lost, a new project delayed, or vital operations interrupted. Serious financial and other losses can be the result.

4. Safe operations are of prime importance. Hazards must be minimized by any and all means both from the standpoint of operator safety and equip-



ment self-destruction without sacrificing economy of operation or increasing product cost.

Production operations that rigorously fulfill these requirements can be highly complex. Such operations, especially where high-level automation is concerned, imply a great deal more than a mere assemblage of machinery. To be efficient, processing must be skillfully managed—that is, carefully planned and expertly executed. Since the manufacturing engineer plays such an important part in this area, the basic principles involved and the fundamental responsibilities of his function are well worth reviewing.

The Manufacturing Process

Actually all manufacturing operations consist of a selection or all of the eight basic steps shown in *Fig.* 1. All the fundamental steps must be integrated and co-ordinated by means of suitable data and operating information. Some form of data processing and distribution must be utilized; today, under automated conditions, the use of automatic data processing offers the most effective means for making practical the use of automatic processing operations.

Such a general chart of basic production processing steps found in manufacture conveys no idea of the necessary engineering and planning involved. Before any work is done, the manufacturing engineer will have studied carefully all possible approaches and developed every step in the automatic process. Once he has supplied the facilities and information with which to carry on the process, production control personnel take over to see that all operations function smoothly, that material supplies match requirements, and that a steady output as needed results. Unless the process has been properly executed, chaos is the result.

Automatic manufacturing can be termed a multi-step process by which materials are converted into products through carefully co-ordinated and integrated systems of automatic machinery supervised by skilled operators. It is important to recognize that manufacturing need not be completely automatic to warrant the description "automation." Manufacturing becomes automated when the processes used to produce products of any variety are performed as continuously and automatically as manufacturing technology, labor availability, materials, product design, and business economics dictate. Thus, automation's greatest asset lies in developing operations into an organized system. And it is in this respect that new important economies can be attained.

Discerning just how far it pays to go in applying automation principles becomes more difficult as the manufacturing process grows more involved. In producing simple products, it is relatively easy to

FUNCTIONAL RESPONSIBILITIES OF MANUFACTURING ENGINEERING

1. PRELIMINARY COST AND PROCESS CAPABILITY STUDY.
2. DEVISE METHODS AND FACILITIES FOR MANUFACTURE.
   - 2.1 Develop Processes and Facilities.
   - 2.2 Prepare Drawings and Specifications.
   - 2.3 Prepare Manufacturing Instructions.
3. PROVIDE MANUFACTURING FACILITIES.
4. EXERCISE ENGINEERING CONTROL OF PRODUCTION.
5. ESTIMATE COSTS.
   - 5.1 Establish Cost Factors.
   - 5.2 Estimate Preparation Costs.
   - 5.3 Estimate Manufacturing Cost.
6. COLLABORATE WITH DESIGN ENGINEERING.
   - 6.1 Help Develop New Designs.
   - 6.2 Exploit New Processes and Materials.
   - 6.3 Exchange Technical Information.
7. OTHER.
   - 7.1 Assistance to Shop.
   - 7.2 Production Capacity Analysis.
   - 7.3 Job Rating.
   - 7.4 Patent Activities.
   - 7.5 Industrial Relations.

Fig. 3—Basic outline showing the typical functional duties found in successful manufacturing engineering operations.

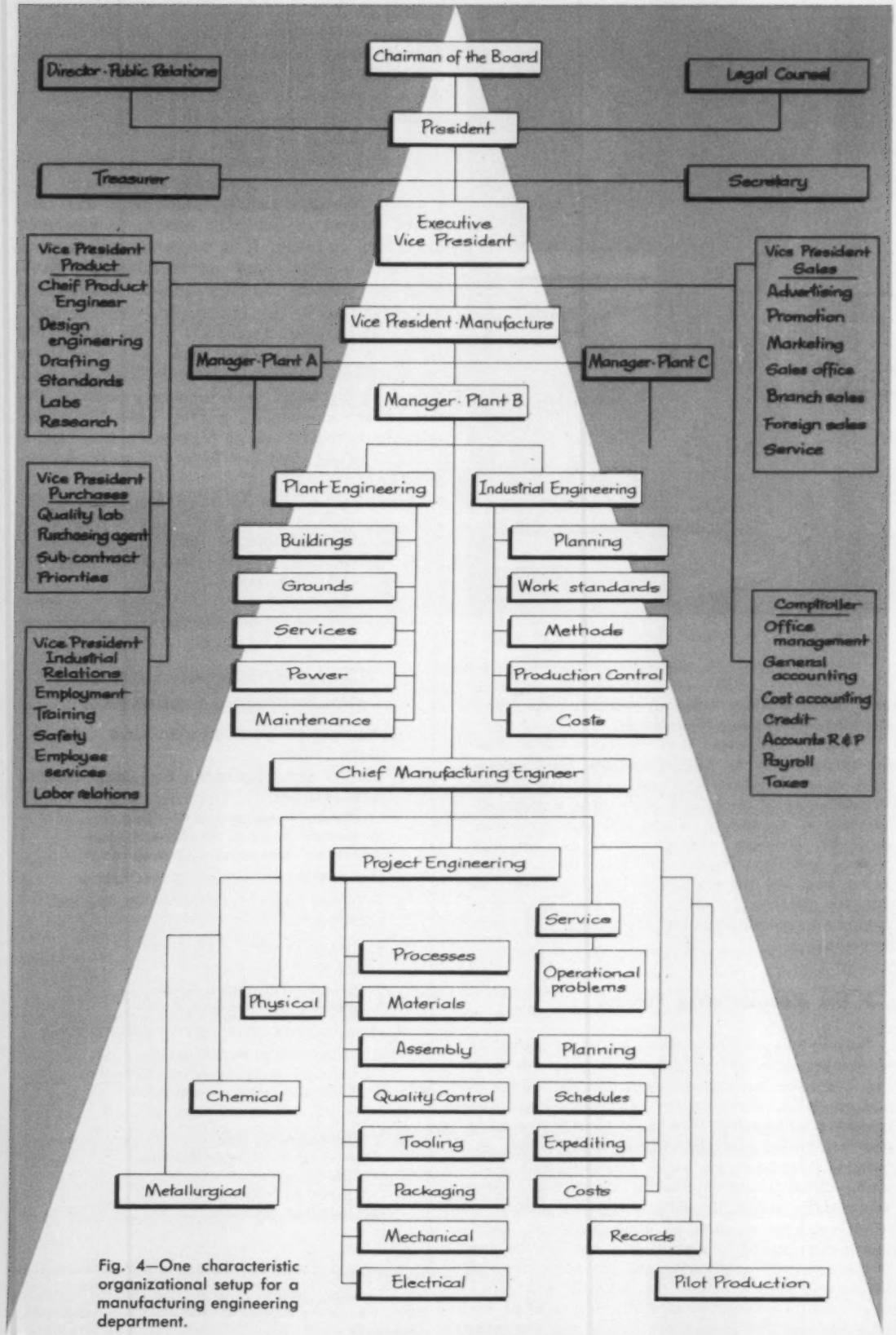


Fig. 4—One characteristic organizational setup for a manufacturing engineering department.

decide by cost comparisons just what degree of automation is justified.

The story is different when more complex products are to be produced or assembled, especially on a large scale. Each basic component and ingredient must be studied individually and the process must be surveyed *as a whole* to insure against bottlenecks and failures. Although bottlenecks can be expensive, so can automatic machinery. Savings possible will never materialize if an expensive machine is provided where a simpler one would carry out the process better.

In addition to this type of consideration there are those of permanence of the installation, the product design, time available for preparations, availability of capital, and adaptability to plant facilities already in existence. Considerable knowledge, experience, and keen judgment are needed to make right decisions in the face of these many complex considerations.

> ". . . the manufacturing engineer's work becomes increasingly more important . . . With the growth in production, he will continue to develop the techniques of manufacturing so that standardized design and processes will be adaptable to the mechanized facilities needed to meet the large scale demands of the future. . ."—*J. E. Genther, Bell Laboratories Record, June* 1958.

▶ Manufacturing Engineering

Efficient and practical automated production will result only when all the basic considerations of automation technology are combined and employed properly. Bringing them together in the correct manner and balance requires engineers who thoroughly understand the principles involved and who have a wide knowledge of materials and the methods suitable for processing them, *Fig.* 2. This group must analyze the design or character of the product, know what is expected of it, and sense whether the product is practical to manufacture with a known method or whether one can be evolved to do the job.

The manufacturing engineer has the role of fulfilling this function. In *Fig.* 3 is an outline of the typical functions of manufacturing engineering. Though not complete, this list includes those activities directly associated with manufacturing. Most of these responsibilities must be discharged before production can commence.

A typical organizational setup for a manufacturing engineering department is shown in *Fig.* 4. To insure effective operation of the group, a number of important factors must be taken into consideration:

1. Pick the right *Project Leader.* 2. Use the *Team Approach.* 3. Co-ordinate with *Product Design.* 4. Clearly *Define the Objectives.* 5. Provide the necessary *Accurate Statistics.* 6. Give the project *Unbiased Backing.*

As soon as a project is assigned, planning for manufacture starts. First, broad general plans are laid down to establish the general configuration of the plant—floor space, flow of operations, and general arrangement of equipment. With the development of more detailed data through study or pilot plant operation, the general plan may be modified and revised. Then, as the general layout takes shape, design specifications for the major pieces of equipment are prepared and released to the company machine shops or to outside machinery builders.

Careful study and analysis of every step in the processing system is made to insure that all details are accounted for and all necessary components are designed or ordered. All equipment needs and associated handling and control facilities must be carefully preplanned so that each is available on the desired date for installation. Planning and co-ordination within the group insures that all vital equipment is on hand and satisfactory, includes follow-through on installation and check-out on individual items. Finally, operation of every piece of equipment is checked for function and safety, the installation is run in and debugged, then turned over to the operating department.

> ". . . industry is still concentrating on the competitive accumulation of premium research and development talent while underestimating its need of production engineering professionals . . . before industry can fully pay itself out on its investment in the last decade's crop of Ph.D.'s, it will have to concentrate for a very full decade on production engineering . . . in recent years, the kind of engineering skills that set up production and make it tick have tended to get lost in the shuffle between the scientists at one extreme and labor at the other. But production takes more than the smock-wearing corps and the overall-wearing team. . ."—*Eliot Janeway, Harvard Business Review, Nov.-Dec.* 1957.

▶ Conclusions

Manufacturing engineering has risen as a new and necessary function in today's complex of industry. For automation the manufacturing engineer performs an ever more important job. His must be a broad "dollars and sense" approach to manufacturing for success in automating operations. His work must reflect the most up-to-date technical thinking and equipment design possible. Only by a fresh, new approach blending the best of past development from all industrial experience with the newest in processes, ingenious mechanisms, hydraulics, pneumatics, electronics, instrumentation, automatic inspection, feedback systems, and integrated data processing, can he achieve the necessary goals to meet future needs of industry.

DEVELOPING MANUFACTURING ENGINEERS . . .

. . . *to meet the challenge of automation*

By **O. S. HULLEY**, Consultant, Manufacturing Training & Education, General Electric Co., New York, N. Y.

ALTHOUGH affecting all functions of a business, automation is possibly of greatest importance to the manufacturing engineers responsible for planning the manufacture of the many products that contribute to our high standard of living. Thus management must understand what automation really means to the manufacturing engineer—and to his job.

It should first be recognized that, though given a new name and considerable publicity in recent years, what automation represents is not new. Automatic production has been a characteristic of many industries, such as chemical products, paper processing, electric lamp manufacturing, printing, and others for some years. However, understanding the "why" of *today's* emphasis on automation will provide the proper perspective with which to view the subject.

An important point is that we have finally realized that both large and small jobs—or parts of manufacturing processes as well as whole processes—can be done more effectively through automation. For example, in the metalworking industry a completely automatic factory might be the ultimate goal, but partial automation of processes is feasible since the ultimate can only be reached by performing each job today in the manner that best contributes to the advantage and to the profits of the enterprise.

Thus, today, automation is not the limited concept that it was just a few years ago. Today, applied

GENERAL ELECTRIC DESCRIBES THE FUNCTION

MANUFACTURING ENGINEERING component is the activity responsible for the determination of those manufacturing processes not specified in detail by Product Engineering, and the determination of the equipment to be used to produce the product to the quality level specified by Product Engineering—at lowest cost, and with full regard for the health, safety, and well-being of employees. Manufacturing Engineering designs and constructs or arranges for the design and construction of processing equipment. It is responsible for determining over-all material flow and master factory layout. It installs or arranges for the installation of such equipment and makes or supervises trial runs to determine performance and operating standards. It furnishes the Shop Operation component basic detailed process plans and time standards. Manufacturing Engineering, therefore, is responsible for the basic planned cost of the product.

Further, Manufacturing Engineering is responsible for advising the appropriate Product Engineering component regarding the manufacturability and relative cost of proposed designs or modifications to existing designs, and for recommending product design changes to lower the cost of, or improve the product.

Manufacturing Engineering will be guided by the Quality Control component in the interpretation of product drawings and specifications as to quality and degree of inspection required, and in appraising and measuring the quality performance of processing equipment. Quality Control will furnish inspection and test requirements and planning for the final processing layout.

Thus, the primary responsibilities of Manufacturing Engineering are meeting long-range manufacturing objectives and effecting major rearrangement or tooling programs.

The major subfunctions of the Manufacturing Engineering function are: Advanced Manufacturing Engineering—Process Engineering—Time Standards—Tool and Equipment Designing—Tool and Equipment Making—Tool and Equipment Maintenance.

Depending on such factors as type of plant, product manufactured, etc., specific job requirements under these subfunctions can vary widely within the general framework of the Manufacturing Engineering function.

For example, here is the position guide for a Manufacturing Engineering position in General Electric Co. identified as:

Specialist-Machine Tool Development

Broad Function. The Specialist-Machine Tool Development is accountable to the Supervisor-Machine Tool Development. The purpose of this position is to provide the best practicable machine tool equipment for the plant.

After reaching an appreciation of the role of manufacturing engineering in automation, management is faced with the problem of obtaining men with requisite abilities. Here, the author highlights important considerations in this critical area—critical because only thoughtful management effort can create the climate in which manufacturing engineers can develop.

automation embraces *all* operations of a business: From office data processing on through the production operations in the factory which are concerned with the making, inspecting, assembling, testing, and packaging of the product.

As a corollary to our understanding of the scope of applied automation, we now realize that automation affects far more than the manufacturing process. To be successful, an automation program must be considered by all functions in the company: Marketing, finance, engineering, and personnel as well as manufacturing. To arrive at the best product design, manufacturing process, and factory layout to produce a product automatically requires a real team effort.

Thus manufacturing—which is responsible for continuous automatic production—must be coordinated more closely than ever with all other functions as the manufacturing plan is developed. This means that the successful manufacturing engineer must be fully conscious of the effect of automation on the other functions in the enterprise—realizing that an effective automation program starts with the market forecast, which must be followed by a product designed for automation before he can finalize his own design of the manufacturing processes and equipment.

Further, the manufacturing engineer must consider automaticity of all steps in the process—making, inspecting, assembling, testing, and packaging—singly, in combinations, or as a whole. A broad background as well as a new and fresh outlook on the entire problem of the production of goods is needed if automation techniques are to be used to best advantage.

Important Qualifications

What then might be some of the characteristics of this modern manufacturing engineer—one who is ready to meet the present day challenge of automation? First, the high technological content of both current processes as well as today's products means that he should be a well-qualified engineer. Next he must have a much greater perspective of the manufacturing enterprise than his own manufacturing engineering function. While he may be a specialist in his own field he also must be a generalist in all other functions of manufacturing and the business as a whole. He must think in terms of any possible effect which manufacturing might have on

In the areas of projects assigned, he is responsible for the analysis of needs, specification, procurement, installation, initial operation and establishment of methods for the machine tools required.

Principal Responsibilities. The Specialist-Machine Tool Development by his own contribution will:

1. For the areas of work assigned, analyze the operations to determine the basic machining requirements.
2. Review available machine tools and cutting tools to determine which may be suitable for the work. Have special tests made where desirable.
3. Consider various combinations and variations of the above to determine which are probably most suitable. Review the problems and proposed solutions with tool venders, devising, where desirable, new tools and new combinations of tools to do the job.
4. Obtain quotations from the venders for the most desirable schemes. Prepare specific plans of procedure, including the economic forecast of results and appropriations.
5. Place orders for machine tools and fixtures through normal channels. Arrange for installation. Correlate schedules. Control expenditures on the project.
6. Superintend installation and initial operation. Establish the methods applicable. Arrange for the establishment of time and pay standards by the Time Standards Unit. Transfer the job to the operating organization. Evaluate results. Close the appropriation.

The Specialist-Machine Tool Development is also responsible for observing and conducting the relationships necessary to the fulfillment of his functional responsibilities and will:

1. Confer with the Supervisor of Machine Tool Development on all major matters important to the Unit's and Sub-Section's success.
2. Maintain close working relationships with the personnel in other Manufacturing Engineering Units and Manufacturing Components, especially those in Planning, Methods, and Time Standards.
3. Establish and maintain communication with other sections, such as Engineering, Finance and Materials, and Processes Laboratory.
4. Establish and maintain communication with other appropriate operating departments and service divisions, especially Manufacturing Research and Development Services Department.
5. Establish and maintain contact with equipment and machine tool venders.
6. Maintain appropriate communications with other companies and with industry and technical groups in the area of primary interest.

Authority and Reservation of Decision-Making Authority. The Specialist-Machine Tool Development has full authority to accomplish the tasks outlined above in accordance with department and company policy. The Specialist-Machine Tool Development has authority to make recommendations in instances where decision-making authority has been reserved, to secure decisions thereon and to take appropriate action thereafter.

. . . to produce a product automatically requires real team effort . . .

the saleability of the product. He must consider the economic aspects not only of product cost but of capital investment involved. At no time can he disregard the intended function of the product, the manufacture of which he is planning. All these things he must consider capably—but above all he must have imagination and creativity!

Only by being imaginative and resourceful can the manufacturing engineer avail himself of the many possible ways in which a problem in automation may be solved. If he tries to follow in the footsteps of others, or hew to his own past experience, he will make little, if any, real progress.

Only by keeping abreast of current developments in materials and processes and having enough vision to associate these developments with his own problems can the manufacturing engineer arrive at a sound plan for automation.

It has been said that applied imagination is creativity! At no other place in our industrial structure is this more evident than in manufacturing engineering.

▶ Finding the Man

Where do we find such a man? How can we develop him? How can we insure his continued progress in the field of automation? Let us take each question in turn.

It is an over-simplification to point out that the manufacturing engineer will come from one of three sources: The engineering school, the technical institute, or from the shop ranks. Although it is felt that an engineering education is desirable, we would be remiss if we did not recognize the many past contributions to automation that have been made by the ingenious machinist or tool and die maker. Yet we must also take a very close look at the trend in the development of these journeymen. With greater automation they will be replaced by the technician; thus it is believed that recruitment from the shop ranks will fall far short in meeting the demand of the future.

What type of graduate can we then expect from the engineering college? Today the trend in engineering education is towards the teaching of basic engineering fundamentals at the undergraduate level and engineering sciences at the graduate level. More emphasis is placed upon the theoretical derivation of engineering principles than upon their practical application. There is much to be said in favor of this educational philosophy. We may be better off to have curricula leading to degrees in mechanical, electrical, industrial, chemical, and other basic fields of engineering. Regardless of the industry or product involved, however, the problems of automation are largely mechanical or electrical in content.

The technical institute is another possible source of personnel. Here greater emphasis is placed on practical application, with the result that the outstanding technical institute graduate should compete effectively in the field of automation.

Thus it is a considered opinion that the majority of candidates for the manufacturing engineers of the future will be engineering or technical graduates. In varying degrees these graduates will be grounded in engineering principles and lacking in practical manufacturing applications. It will be industry's responsibility to develop the automation engineer from this basic raw material

Regardless of where the candidate comes from—engineering college, technical institute, or the shop floor—there is a development job to be done. A Manager of Manufacturing of one of the General Electric Co's operations recently pointed out that his best automation engineer was an apprentice graduate or a journeyman tool and die maker, who had gone on to college and now held an engineering degree and who had worked for several years in the area of automation. This manager felt that in spite of the engineer's excellent training and education for the job, the greatest progress was made after he was actually working at many problems encountered in his job.

Since it is apparent that development is required, how can industry expedite the automation engineer's development?

▶ Training the Man

In any education or training problem there are five principal factors which, if considered, will lead to a reasonably sound solution in terms of the best development methods. Each development program should be carefully studied in reference to: 1. Objectives of the program. 2. Time to be allotted to the program. 3. Student or trainee qualifications on entering the program. 4. Scope and difficulty of the information or skills to be be taught. 5. Availability and qualifications of instructors. From this study the most appropriate method or methods of development can be determined. A few general observation are in order.

First, the objectives of a program for development of automation engineers will vary from industry to industry, and from plant to plant. It is true that within the general objectives there will be many in common. The point to be made is that each company or manufacturing organization interested in such a program should spell out just what they

intend to accomplish. Objectives must be quantitative, i.e., how much do you want the trainee to learn, or what degree of skill is to be mastered. The advantages of doing this as opposed to just merrily starting down the road and training automation engineers is more or less obvious. While it is true that these objectives will change from time to time, nevertheless they keep the program on a definite course and should result in accomplishing more in less time. Definite bench-marks must be established.

Next, it is important to make a decision as to the time you wish to spend in the development program. Again this is a dynamic factor and subject to change. As a matter of fact, the original estimate of time may be revised prior to the start of the actual program. This change will result from arriving at an appropriate balance between the other factors and the methods of development selected.

The third factor, the candidate's qualifications, has been discussed previously. However, once starting on a program this becomes very important. Actual people are involved and their qualifications must be reviewed carefully. It is axiomatic that an individual's development must start from where he is—not where you think he is or where you would like to have him!

The scope of the program and its content will vary with your own industry, products, and processes. This analysis should result in a program to fit only the needs of your own company—no other. Thus, instead of spending time in areas for which your engineers have little or no need, you will be maximizing their efforts towards accomplishing your common goals.

The last factor, that of the availability and qualifications of instructors, is probably the most important! No matter how well a program is laid out and material prepared, its success is totally dependent on the ability and skill of the instructor. In this we are not referring to formal classroom activity exclusively. On-the-job coaching is no doubt one of the best development methods and it, too, requires an instructor with real ability if optimum results are to be obtained.

▶ Training Details

As to the methods of development, there are two basic categories: On-the-job and off-the-job. Of the two, if well done, on-the-job methods are usually the most effective. For the development of automation engineers what on-the-job methods might be considered?

. . . if he tries to follow in the footsteps of others, he will make little if any, real progress . . .

. . . it may be necessary to start him working alongside an experienced engineer . . . make sure that on-the-job coaching is well done . . .

If you are fortunate enough to have a manufacturing process laboratory in which automation projects are being worked on, this is where the trainee belongs. However, if he is to progress, the trainee must be assigned tasks that require his maximum effort, both mentally and physically. It may be necessary to start him off slow, working alongside an experienced engineer, but a careful record of his accomplishments must be maintained with a view towards getting him to a lead position in a project as soon as he demonstrates the slightest possibility of carrying off the job in a satisfactory manner.

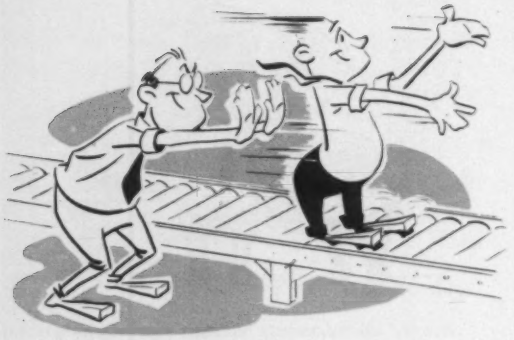
Make sure that on-the-job coaching is well done. This may mean some development of instructors—but it is a truism that the instructor learns more than the student. Hence, your development program extends to the instructor, to the benefit of your entire organization.

Just as important as on-the-job coaching is the evaluation of the progress of the trainee. If possible get valid and objective readings on his progress. These should be discussed directly with him and both his strong and weak points indicated. Suggest how he may correct his deficiencies and build on his better characteristics.

If no laboratory is available, make a laboratory of your whole operation! In other words put the new man in automation work and let him progress in the same way as if you did enjoy a separate laboratory for automation project development.

Finally, with regard to the on-the-job activity be sure to permit the trainee to put full time on automation work. Half time on this development and half time on other regular duties will result in a much less proportionate gain in the man's progress.

For off-the-job training it may be to your advantage to develop a supplemental educational program. If enough individuals are involved you may be able to organize classes within your own organization and use your better qualified personnel as in-



. . . make a laboratory of your whole operation . . . put the new man in automation work . . .

structors. Other possibilities in this area of development would be to arrange for classwork to be conducted by a nearby college or university. Another suggestion is to enroll your trainees in regular classes conducted at the school.

Obviously there are many subject areas that can be covered through formal classroom instruction, or if necessary by self-study on the part of the trainee. Advanced electronics and mechanics offer a real challenge. Courses in mechanisms, controls, and advanced machine design may be applicable. Again this study curriculum can be devised to fit the individual needs of the company, thus avoiding time and study in areas not applicable to your automation problems.

Again, make sure that the educational phase of your problem is challenging. It is suggested that lectures as such be avoided—base your course work on the solution of automation problems. If these problems are brought to the class from the workplace they will serve to stimulate class interest and participation. Individual and group participation should be maximized in this off-the-job development.

Where does creativity fit into this whole picture? How much creativity does the engineering school impart to its graduates? Can you teach creativity in connection with your development program?

It is suggested that creativity be emphasized in all stages of the program. Mr. Alex F. Osborn in his book, *Applied Imagination*, indicates that creativity is teachable. But memorizing the book from cover to cover will not increase creative ability. As pointed out earlier, applied imagination is often referred to as creativity. It is both a skill and a state of mind—a willingness to think freely, visualize possibilities, recognize opportunities, and associate ideas and problems. Creativity in a program for the development of manufacturing engineers to meet the challenge of automation is the all pervading prerequisite. How many "crack-pot" ideas of the past years have proven in the final analysis real "goldmines"? This climate of creativity must permeate your entire manufacturing organization. Each suggestion should be accepted, then challenged to see if there is still a better way.

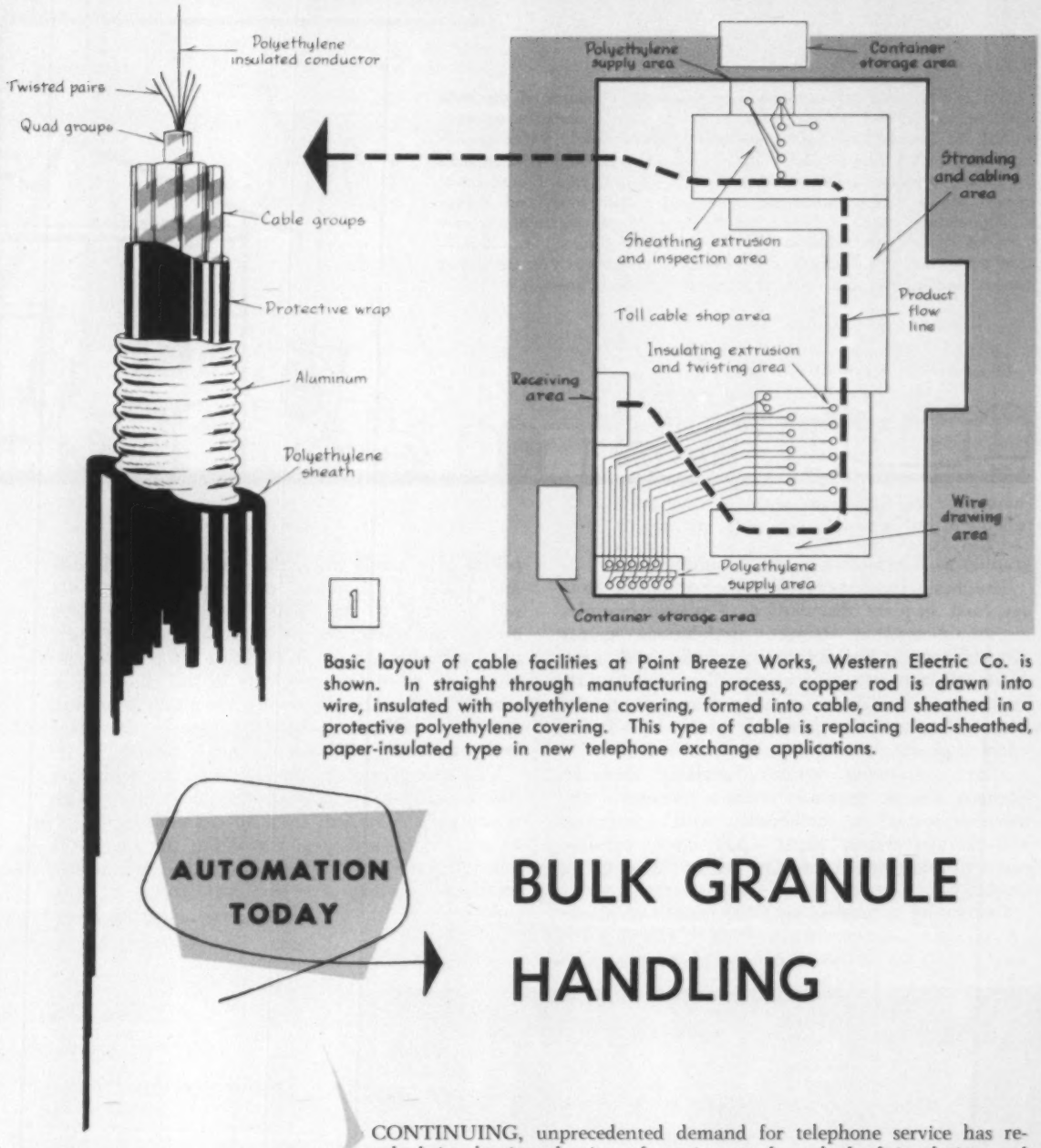
Creating a healthy climate of recognizing and then rewarding proven contributions to your automation problems is the best way to insure the continued growth of your manufacturing engineers in keeping up with manufacturing progress. In most cases these contributors to the effectiveness of your manufacturing operations, and thus to your profits, are not eligible for suggestion awards. Nor are they the managers who are more often recognized as major contributors to a manufacturing organization's success. Hence, as a final step in your program make sure that credit is given where credit is due—not only by monetary reward, but also by acknowledgement of a job well done!

THE AUTHOR

OLIVER S. HULLEY is eminently qualified to discuss the training and developing of manufacturing engineers for the age of automation. Since his graduation from Purdue University in 1924 with a degree in mechanical engineering, his career has uniquely bridged the practical and theoretical aspects of both engineering and education. Prior to World War II he accumulated some 16 years industrial experience in various industries and in various capacities, including manufacturing, engineering, sales, and management positions. During the war he served on the staff of The Artillery School, Ft. Sill, Okla.—one of the armed forces primary training centers charged with developing doctrine and putting into practice those advanced techniques necessary to train the thousands of artillerymen required during the war.

After the war, Col. Hulley accepted an appointment as professor of Industrial Engineering at Purdue University. During his 9-year teaching tenure, he co-authored a basic text devoted to the subject of manufacturing organization (Amrine, Hulley, Ritchey; *Manufacturing Organization and Management*; Prentice Hall, 1957).

He assumed his present position as Consultant, Manufacturing Training and Education, General Electric Co., in 1954. Among the technical societies in which he is presently active are the American Institute of Industrial Engineers, American Society of Tool Engineers, Society for Advancement of Management, and American Society for Engineering Education.



Basic layout of cable facilities at Point Breeze Works, Western Electric Co. is shown. In straight through manufacturing process, copper rod is drawn into wire, insulated with polyethylene covering, formed into cable, and sheathed in a protective polyethylene covering. This type of cable is replacing lead-sheathed, paper-insulated type in new telephone exchange applications.

AUTOMATION TODAY

BULK GRANULE HANDLING

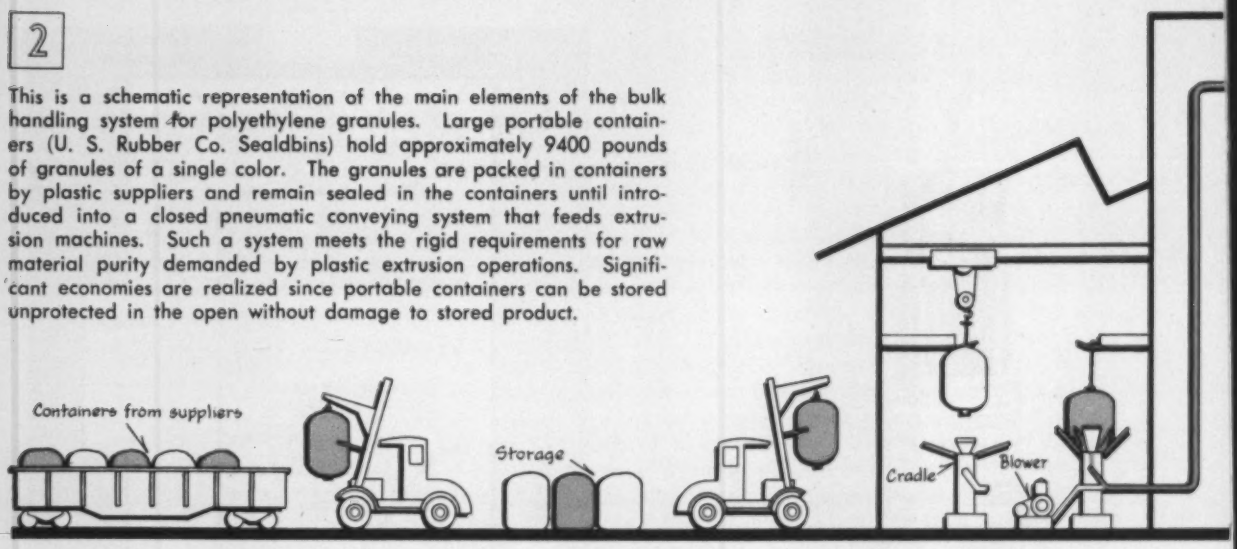
CONTINUING, unprecedented demand for telephone service has resulted in the introduction of an improved method of insulating and sheathing telephone exchange cable. Replacing the lead-sheathed cable containing paper-insulated conductors, in use for many years, is a new version consisting of polyethylene-sheathed cable containing polyethylene-insulated conductors.

To manufacture the new cable form in required quantity, Western Electric Co. has established a major cable facility at their Point Breeze Works in Baltimore. The facility includes: A wire drawing area in which 5/8-inch copper rod is converted to 19, 22, 24, and 26 gage conductor wire. An insulating area in which the wire is provided with colored polyethylene insulation by means of extruding machines. Twisting, stranding, and cabling areas in which a multiplicity of conductors is progressively formed into cables. A sheathing area in which cable is provided with black polyethylene sheathing by means of large extruding machines.

A major problem faced by the plant's designers was the task of selectively supplying 11 different colors of plastic granules in required quantities to 44 extruders in the insulating area and large quantities of a single color

2

This is a schematic representation of the main elements of the bulk handling system for polyethylene granules. Large portable containers (U. S. Rubber Co. Sealdbins) hold approximately 9400 pounds of granules of a single color. The granules are packed in containers by plastic suppliers and remain sealed in the containers until introduced into a closed pneumatic conveying system that feeds extrusion machines. Such a system meets the rigid requirements for raw material purity demanded by plastic extrusion operations. Significant economies are realized since portable containers can be stored unprotected in the open without damage to stored product.



granule to 8 extruders in the sheathing area.

The basic handling problems of shipping, storage, and in-plant distribution of plastic granules are complicated by stringent prohibitions against contamination. For optimum extruder operations, polyethylene has to be free from dirt and moisture. To preserve the telephone cable color code system, it is vital to prevent intermixing of the 11 different colors of plastic.

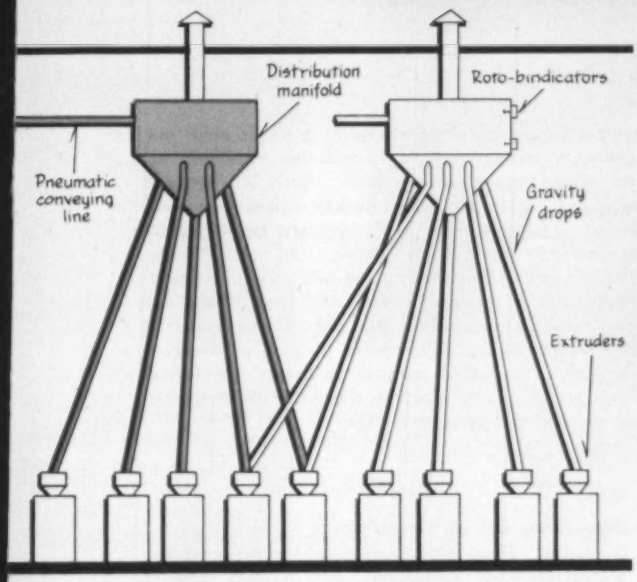
After considering various handling methods, Western Electric engineers chose a pneumatic distribution system in combination with a shipping and storage system based upon large, portable neoprene-and-fabric containers leased from U. S. Rubber Co.

Containing approximately 9400 pounds of plastic pellets of a single color, the containers are loaded and sealed at suppliers' plants and shipped via rail or truck to the Point Breeze Works. Upon arrival, the containers are stored outside the plant on a concrete apron. A modified lift truck is employed to move the containers in the yard and to a ready area in the plant when the plastic is needed. Further handling of the containers in the plant is by manually operated overhead cranes.

The containers are provided with an unloading sock attached to the bottom of the container. With a container mounted on a special holding cradle at one of the supply points within the plant, the unloading sock is extended and attached to a flexible connection leading to a pneumatic conveying line, permitting plastic granules to feed into the pneu-

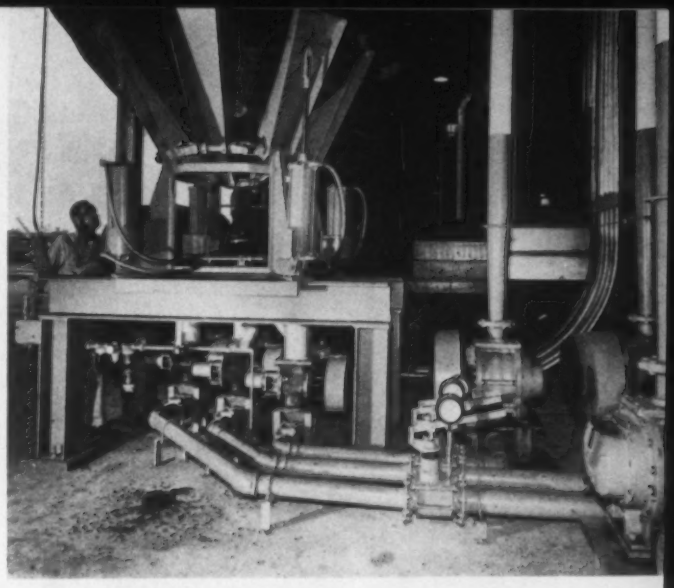
3

Colored polyethylene insulating material is introduced into the conveying system from this supply area. There are 11 supply points, one each for the primary colors of insulation that are extruded onto wire. Containers are raised into position by overhead crane and lowered onto special cradles. A snubbing beam above each cradle supports the top of the container and prevents it from collapsing as granule material is withdrawn. As the container empties, bottom of container is formed into cone by cylinder-actuated radial arms of the cradle, insuring complete discharge of product.

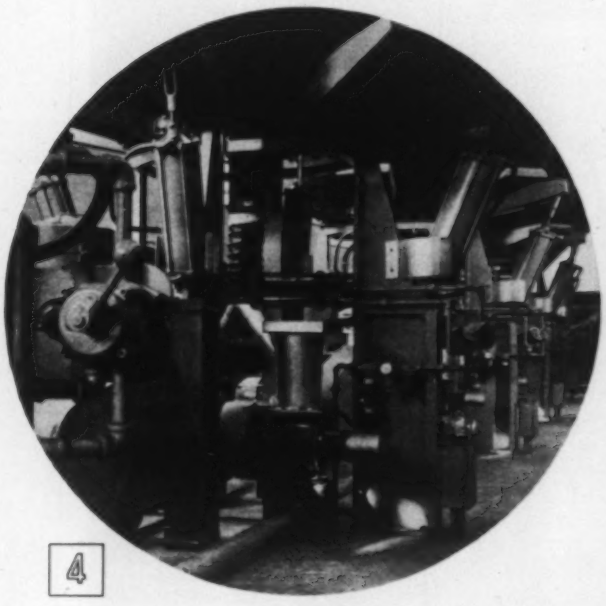


matic system linking supply points and extruders.

Two pneumatic conveyor systems, furnished by Dracco Div., Fuller Co., make up the polyethylene distribution complex. One handles various colored granules for the insulating extruders, and the other handles black granules for the sheathing extruders.



5 **Black polyethylene sheathing material is supplied to a separate conveying system located at opposite side of plant from the insulating system. Here, two unloading cradles are located. Five individual pneumatic conveyors are served by these two unloaders. Sheathing polyethylene will readily absorb moisture, to detriment of extrusion operations, and in this system the granules are conveyed by dehumidified air piped to the intake of each conveyor line from cable drying ovens within the plant.**



4 **Each container is provided with an unloading sock, recessed into container bottom and covered by a metal plate. In preparing the container for discharging, the cover plate is removed and the unloading sock is withdrawn and attached to a flexible connection leading to a rotary feeder in a pneumatic conveying line. Granules flow into the feeder by gravity and are fed into the line by an injector. Each conveyor line is equipped with its own blower which introduces filtered air into the system at 250 cfm, carrying the granules at speeds up to 5000 fpm. System pressures vary between 2½ to 7 psi, depending on length of piping.**

The insulating extruder system includes 11 separate conveying lines, each with its own blower and separate container supply point. In addition, there is a twelfth conveyor line that can be connected to any of the 11 supply points. The sheathing extruder system includes two supply points that feed granules to a total of five conveying lines, with provisions for a sixth line if production warrants.

From the various supply points, granules are conveyed for distances varying from 100 to 720 feet to aluminum distribution storage bins mounted in the plant roof structure over the lines of extrusion machines. The top section of each storage bin serves as a cyclone separator, dropping polyethylene into the bin and discharging conveying air through a roof vent.

Conveying lines are of 3-inch aluminum tubing with 0.065-inch wall. The inside surfaces of the conveying lines and the bins have been roughened by sand blasting. This prevents the build-up of film that occurs on smooth surfaces when exposed to polyethylene being conveyed at high velocities. Unless controlled, the film could build up and then tear loose in long ribbons that would form a tangled mass and stop product flow.

Individual extruders are fed through gravity drops leading down from the bins. To provide sufficient flexibility in meeting varying production schedules for insulation of different colors, the 11 main storage bins are provided with a total of 62 gravity drops. The particular arrangement of these drops

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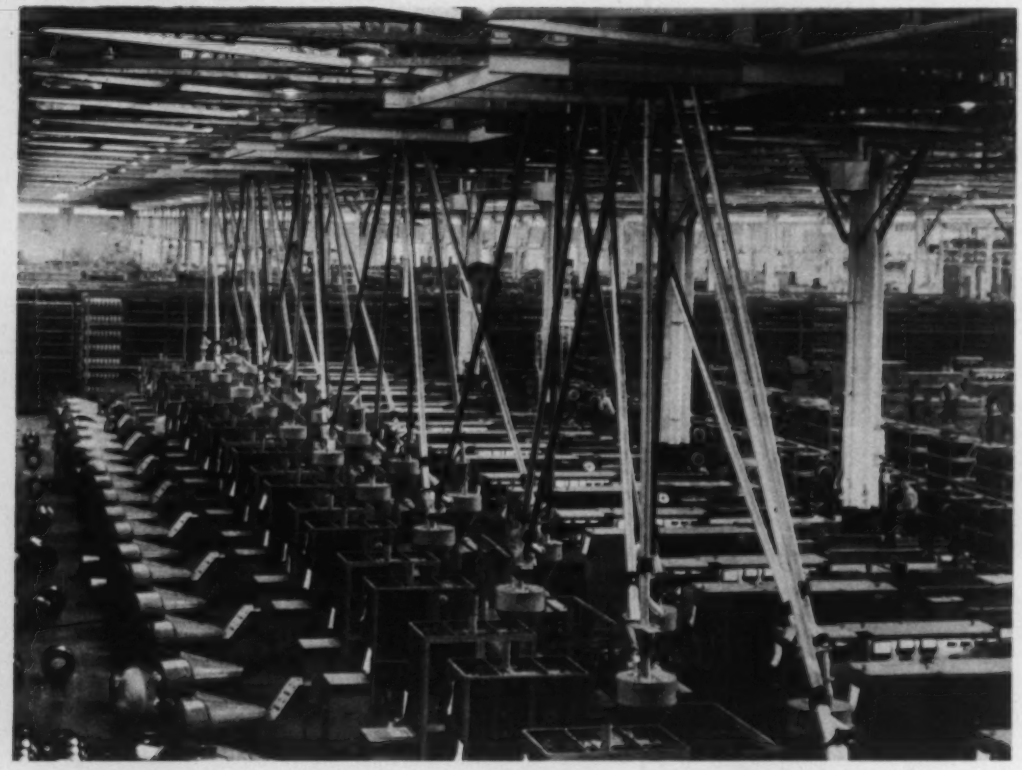
From the supply points, granules of a single color are conveyed to storage bins, or distribution manifolds, located above groups of extruders. Each bin contains a low-level and a high-level paddle wheel type level indicator. Signals from the indicators automatically start and stop the conveyor blower and rotary feeder in the pneumatic line feeding the bin. Control design provides that a conveyor blower will start 30 sec before the rotary feeder and will stop 30 sec after the rotary feeder to insure complete purging of the conveyor line. As shown, various extruders are served by two storage bins to allow flexibility in scheduling color of insulation placed on wire.

permits either five or six extruders to be connected to each bin. Flow into each extruder is controlled by an operator by means of a gate located in each gravity drop. The two supply points in the sheathing extrusion system handle only black granules, and here five storage bins provide granules to eight extruders. Accompanying photos indicate details of this unique bulk handling system.



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Over-all view of a portion of the 44 insulation extruder lines served by the pneumatic handling system is illustrated. On each line, bare wire from supply reels (left) is cleaned, annealed, covered with extruded insulation, tested, and then rewound on take-up reels. As many as 808 of these individual conductors are formed into cables prior to sheathing. The illustrated insulation extruding machines consume between 100-150 pounds of plastic per hour. In the cable sheathing operation, consumption per extruding machine varies from 600-1000 pounds per hour.

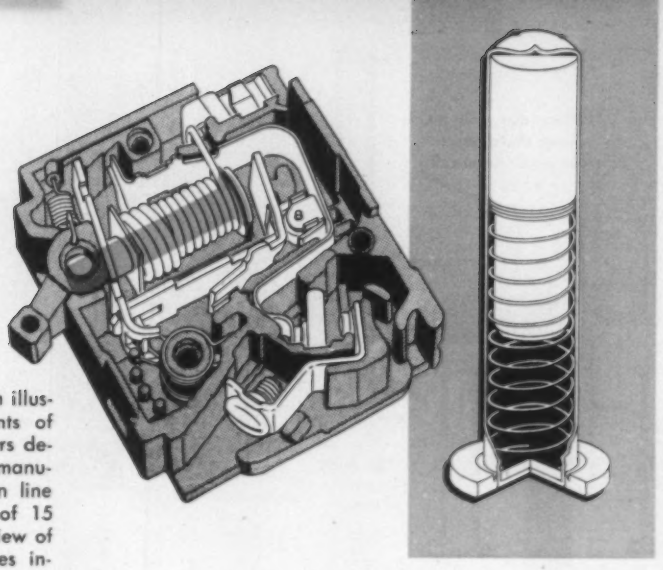


Fig. 1—Cut-away sketch illustrates major components of electrical circuit breakers designed for automatic manufacture. Five models in line cover capacity range of 15 to 50 amp. Enlarged view of core assembly illustrates internal elements.

CIRCUIT BREAKER MANUFACTURE

PRODUCING CORE ASSEMBLIES

Vital elements of a new line of electrical circuit breakers, magnetic core assemblies might have been manufactured and assembled by relatively obsolete methods employing many manual operations. By planning for automatic manufacture in the product design stage, however, a high quality product was made at the outset on highly productive equipment.

By JOHN V. ALLEN and THEODORE F. ARONSON

Project Engineer, Murray Mfg. Corp., Brooklyn, N. Y.
President, Halm Instrument Co. Inc., Long Island, N. Y.

AUTOMATION has been favored with an opportunity to present in detail a step-by-step description of an automated system for making, assembling, and testing electrical circuit breakers.

As Paul Murray, president of Murray Manufacturing Corp. states: "We are returning to AUTOMATION readers a bit of their own."

This presentation describes a part of the system which produces one of the subassemblies.

MANUFACTURING concerns that are contemplating marketing a new product or product line are indeed fortunate when their managements recognize the quality and productivity advantages of automatic production. Company engineers are then in a position to plan for this manufacturing concept in the product design stage.

Resulting opportunities to "design out" manufacturing bugs on paper, to synchronize product design and manufacturing functions, and to make the inevitable compromises between theoretical and

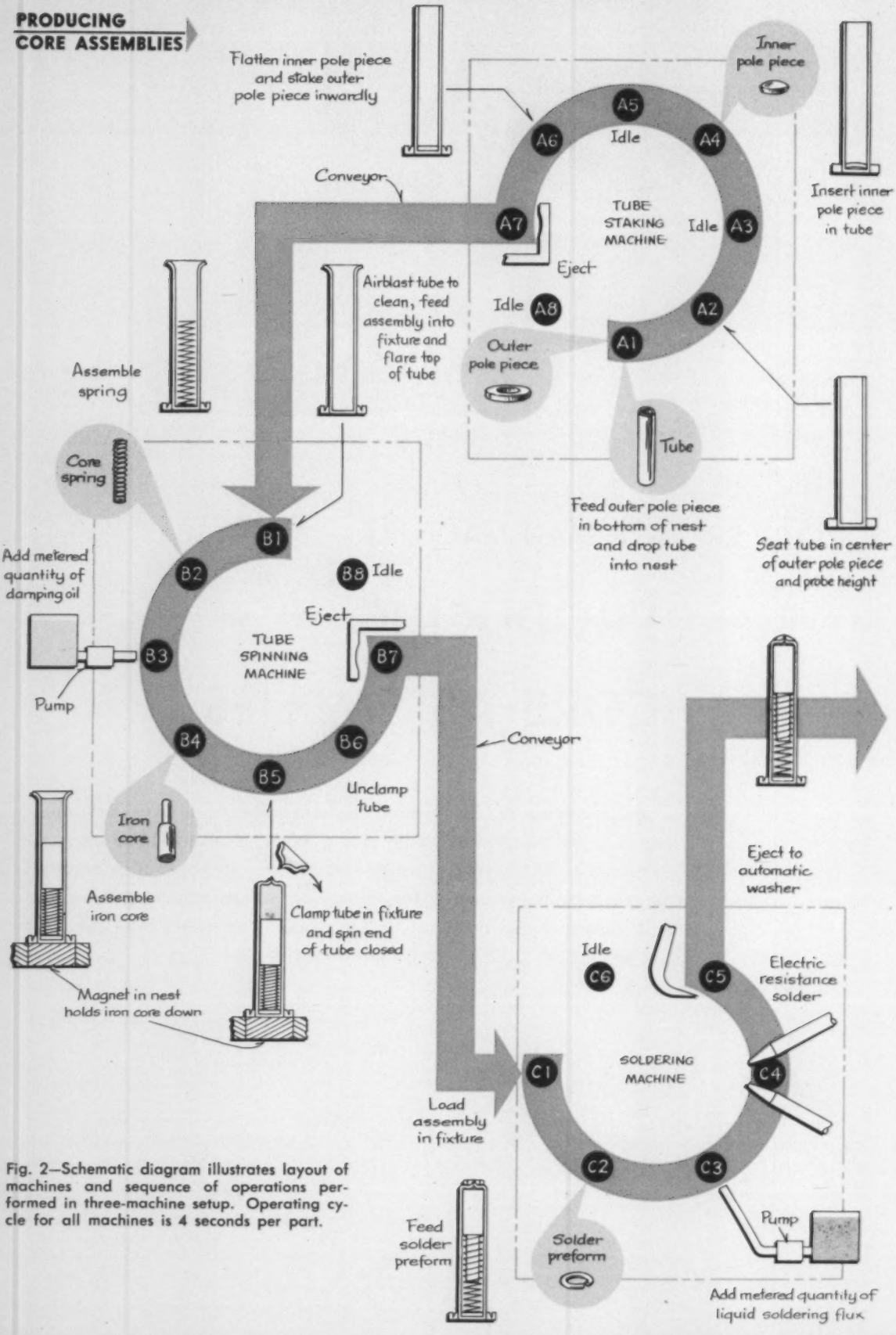


Fig. 2—Schematic diagram illustrates layout of machines and sequence of operations performed in three-machine setup. Operating cycle for all machines is 4 seconds per part.

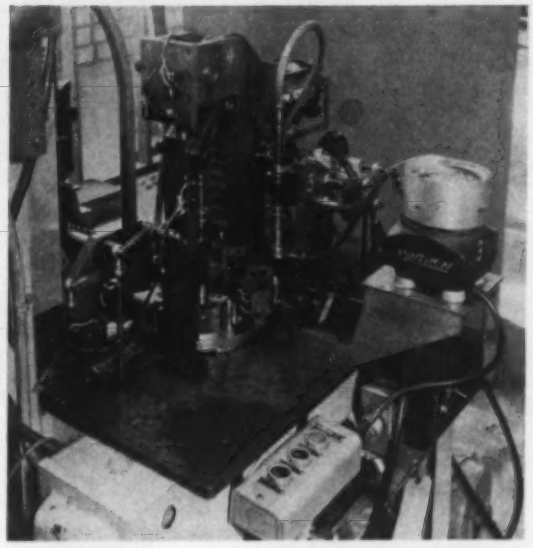


Fig. 3—Over-all view of tube staking machine that assembles outer and inner pole pieces to tubes. Components are automatically fed and are locked together by flattening and staking operations.

practical objectives at least cost can greatly improve the probability of success in marketing the new product. Conversely, the company that can avail itself of cost savings at the outset by adopting automation techniques is in a position to introduce a superior product at prices that are competitive with similar, but less-efficiently produced, "run-of-the-mill" items.

At Murray Mfg. Corp., a new line of electrical circuit breakers, *Fig.* 1, covering a 15 to 50 amp capacity range with five models, was designed specifically for automatic manufacture and testing. Annual production capabilities of 1¾ million circuit breakers per shift rank this project in the small to medium volume class, yet production efficiency is no less than that attainable by giant industries who can afford to make multimillion dollar investments in their productive equipment.

This article will describe the facilities that produce the core assemblies shown enlarged in *Fig.* 1. Operations automatically performed include assembling, staking, flaring, spinning, and soldering.

▶ Three Integrated Units

Receiving the "go-ahead" from their management, Murray product design engineers got in touch with Halm Instrument Co. Inc., an automation engineering and machinery building group, early in the product design stage. The resulting co-operation and mutual interchange of ideas possible from the project's inception led to the successful development of three separate indexing machines that produce core assemblies automatically on a 4-second cycle.

Basically, the machines are constructed from mul-

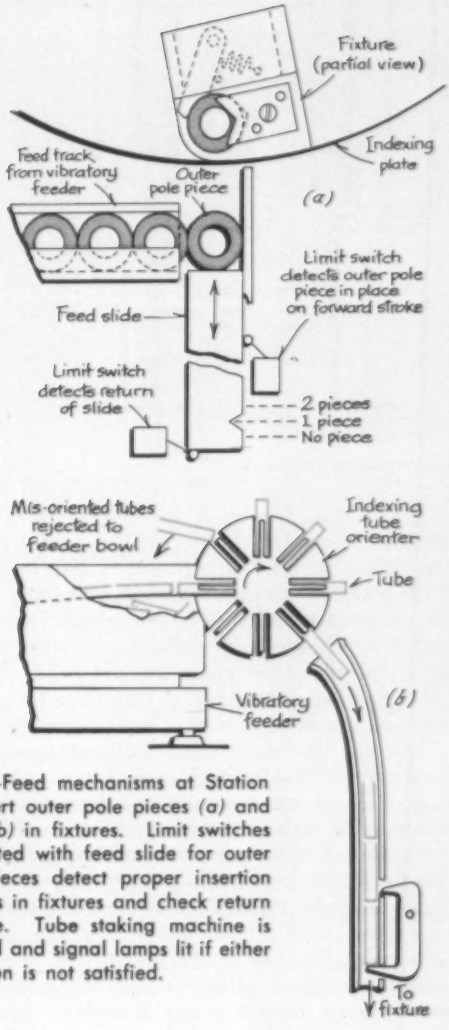


Fig. 4—Feed mechanisms at Station A1 insert outer pole pieces (*a*) and tubes (*b*) in fixtures. Limit switches associated with feed slide for outer pole pieces detect proper insertion of parts in fixtures and check return of slide. Tube staking machine is stopped and signal lamps lit if either condition is not satisfied.

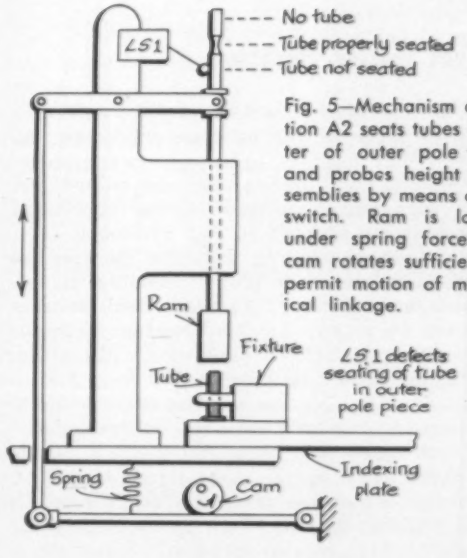


Fig. 5—Mechanism at Station A2 seats tubes in center of outer pole pieces and probes height of assemblies by means of limit switch. Ram is lowered under spring force when cam rotates sufficiently to permit motion of mechanical linkage.

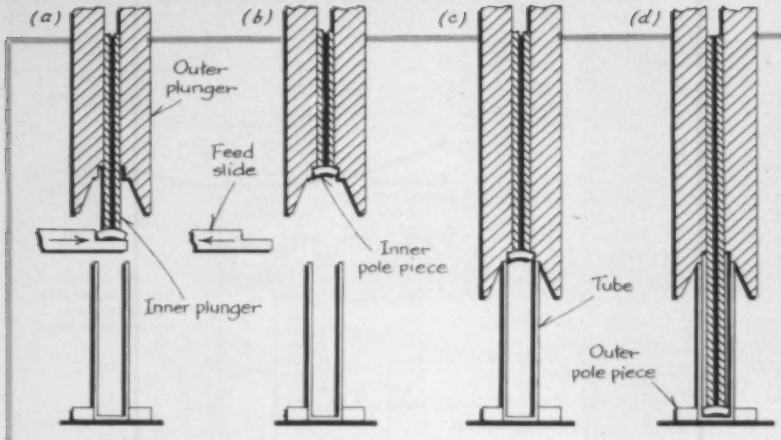


Fig. 6—Inner pole pieces are inserted in bottoms of tubes at Station A4. An inner plunger picks up pieces from a feed slide and holds them by vacuum (*a*). Inner plunger retracts into outer plunger to center piece, and feed slide retracts (*b*). Plunger assembly descends and centers on tube (*c*). Inner plunger extends to seat inner pole piece at bottom of tube, and vacuum is cut off (*d*). Plunger assembly retracts to complete insertion cycle.

tistation indexing units. Auxiliary equipment includes electrical controls, hopper and magazine feeders, fluid pumping units, a vacuum-generating system, and an electric resistance soldering unit. Compressed air, as well as electrical services, are employed. The layout of the three machines and descriptions of the operations performed at the various indexing positions are illustrated diagrammatically in *Fig.* 2.

Although the three units are interconnected by conveyors so that normal operation is continuous, each machine can be operated independently. This allows each unit to be used to accumulate float stock during either preventive maintenance or unscheduled downtime intervals for its companion units. From the point of view of equipment development, segmented construction of this type facilitated initial debugging and prove-in of the units. Use of multiple units also allows greater access for maintenance and improves reliability over a single, complex machine. A system of signal lights associated with each machine further speeds maintenance by indicating the indexing stations at which malfunctions have occurred.

▶ Tube Staking Machine

The first unit, *Fig.* 3, which assembles outer and inner pole pieces to a brass tube and stakes the assembly rigidly together, is an eight-station indexing machine of which three stations are unused. Details of parts-assembling and staking stations of this machine are sketched in *Fig.* 4 through 7.

Use of limit switches to probe for the presence of good parts, and their proper assembly, is well illustrated in this series of diagrams. Limit switches also detect the return of critical machine elements. In *Fig.* 4, for example, a limit switch detects the return of the outer pole piece feed slide at Station A1. Failure of the limit switches to operate due to defective work, improper assembly, or malfunctioning of any station will cause the machine to stop and a signal lamp for the affected station to light.

An interesting design feature is incorporated at Station A4, *Fig.* 6. Here, vacuum applied to the

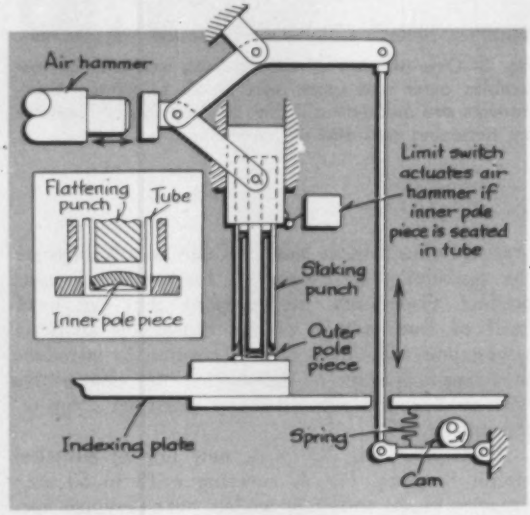


Fig. 7—Operations at Station A6 include flattening inner pole piece and swaging outer pole piece inwardly against tube to form rigid assembly. Initial action occurs when cam rotates away from link, permitting spring to lower punch assembly into and around tube. If inner pole piece is present and bottomed in tube, a limit switch next actuates an air hammer that delivers powerful blow to toggle linkage for flattening and swaging action.

longitudinal channel in a tubular inner plunger serves to pick up and retain inner pole pieces during their assembly to tubes. Raising of the inner plunger inside an outer plunger automatically centers the workpieces in a cavity formed at the end of the outer plunger. When the plunger assembly is lowered over the fixture, the plunger assembly, tube, and inner pole piece are concentric. The vacuum is cut off when the inner pole piece is bottomed inside the tube by extension of the inner plunger.

Cam operation, wherein cams rotate to positions allowing springs to advance the machine elements, is used extensively. This is illustrated in *Fig.* 7, Station A6. In this instance, a cam-released spring causes

initial positioning of a flattening and swaging punch assembly. Subsequent actuation of an air hammer that operates a toggle linkage to effect flattening and swaging cannot occur unless the punch assembly has first bottomed on good work by spring force. The latter condition is indicated by a limit switch.

Tube Spinning Machine

Tube assemblies discharged from Station A7 of the staking machine are conveyed to an eight-station indexing machine, *Fig.* 8, where additional components are assembled, damping fluid is added, and the assembly is spun closed at its top.

At Station B1 of this machine, tube assemblies are airblasted before being fed to the fixtures. When they have been inserted in the fixtures by a slide, a flaring operation on the open tube ends prepares the tubes to receive additional components and fluid.

Core springs are fed into the tube assemblies from a hopper feeder at Station B2. Springs, shipped by the manufacturer in containers that keep them in end-to-end orientation to prevent tangling, are fed directly from their containers into the bowl of the feeder. Tracks inside the feeder bowl convey the springs in a downward spiral to an escapement tube. The feeder bowl provides 6 feet of storage track in an area of one square foot.

At Station B3 a metered quantity of damping oil is added to the tube by cam operation of a constant-displacement pump. The purpose of this oil is to prevent short-period current surges (as during motor starting) from triggering the circuit breaker, and to reduce any tendency of the unit to chatter.

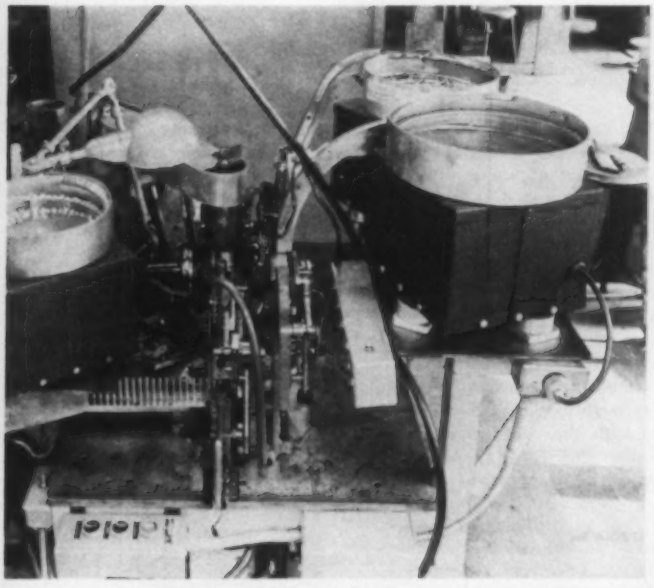


Fig. 8—Spinning machine inserts core springs, damping oil, and iron cores into tubes and spins tubes closed at their tops. Magnets in bases of fixtures hold iron cores down with core springs compressed during tube spinning operation.

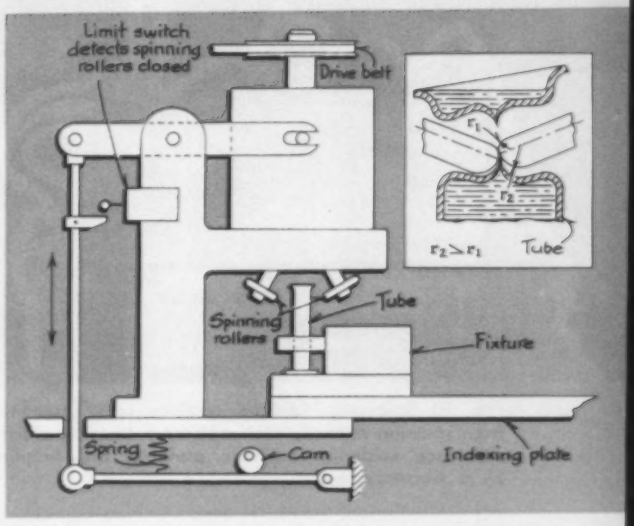


Fig. 9—Open ends of tubes are spun closed at Station B5 by mechanism shown. Excess oil is removed with scrap piece. Limit switch detects complete closing of spinning rollers on tube. Enlarged view of spinning rollers shows offset arrangement and nonsymmetrical rounding needed to give desired shape to spun section of tube.

Iron cores are hopper fed on top of the springs in the tubes at Station B4. They are forced to bottom on the inner pole pieces by an inserting ram, and are held down against spring force by magnets placed in the bases of the indexing fixtures. This is done to facilitate the next operation of spinning the tops of the tubes closed.

One of the most difficult operations to iron out proved to be spinning the tops of the tubes closed at Station B5. Because a special internal configuration of the tube was required at its top as shown in the enlarged view, *Fig.* 9, the spinning rollers had to be offset from one another and be rounded in a nonsymmetrical manner. This insures pinching off of the scrap piece and also forms a circular projection inside the tube at its top. This projection prevents sticking of the oil-immersed iron core.

Soldering Machine

After they have been spun closed, tube assemblies are ejected at Station B7 of the spinning machine and are conveyed to Station C1 of a six-station soldering machine, *Fig.* 10, where they are loaded into fixtures.

At Station C2 of the latter machine, solder preforms are hopper fed and placed one-at-a-time on the tops of the tubes by the device illustrated in *Fig.* 11. Liquid flux in premeasured quantities is dropped on the solder rings at Station C3, and carbon rods are clamped on opposite sides of the tubes at their tops at Station C4 to effect melting of the solder. Completed core assemblies are ejected

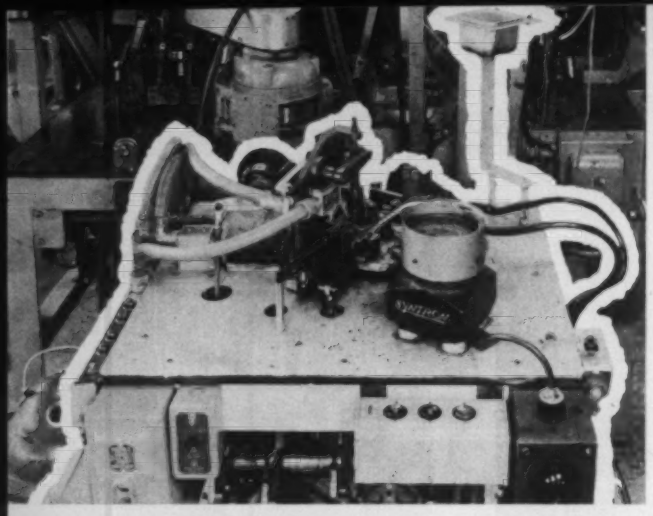


Fig. 10—Soldering machine receives core assemblies from spinning machine and seals spun ends by electric resistance soldering. Solder preforms are supplied by a vibratory feeder.

from the soldering machine at Station C5 and fed to a conventional automatic washer.

▶ Best Time To Automate

Economic and technical feasibility of an automation program is never more probable than at the inception of a new product's design, as this installation illustrates. At this time there are no outmoded facilities to write off and physically dispose of, new equipment and tooling can embody latest technology, and a completely unbiased viewpoint can be adopted by product design and manufacturing groups working together. The exhortation "buy now," in relation to automation, is more meaningful at this time than at any other.

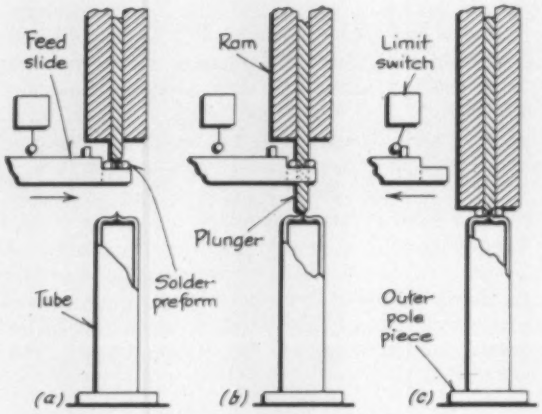


Fig. 11—Solder preforms are placed on top of tubes at Station C2. A bifurcated feed slide presents preforms to a ram and plunger assembly *(a)*. The plunger descends, threading through the center of the preform and contacting the top of the tube *(b)*. The feed slide retracts and the ram lowers, centering the solder preform on the tube *(c)*. The ram and plunger assembly retracts to complete the cycle. Recycling requires that a limit switch be actuated by return of the feed slide.

THE AUTHORS

John V. Allen, left, has been with Murray Manufacturing Corp. for more than twenty-five years, and has been instrumental in the development of some of the first automatic machinery used at Murray. A graduate of Manhattan College, Mr. Allen is presently a project engineer with the firm. In this capacity he worked closely with Halm Instrument Co. Inc. personnel, approving blueprints, plans, and scale and working models for the subject installation. Mr. Allen states: "Several of my basic premises concerning automated systems at Murray were formulated after reading AUTOMATION. As an engineer involved in manufacturing, it became more and more evident that to maintain a competitive position with the industrial giants, we simply had to automate."

Theodore F. Aronson, right, president of Halm Instrument Co. Inc., advanced into the automation field naturally when, after a wartime stint at Sperry Gyroscope Co. manufacturing precision automatic gunsighting equipment in quantity, he and three other engineers were presented with the problem of devising equipment to gage surgical sutures automatically. The four young engineers used the experience gained from this assignment as a springboard for organizing their own firm. Since its formation thirteen years ago, this company has designed and built automatic machinery for electrical manufacturing, high speed paper feeding and printing, ampule filling, hosiery packaging, and audio-visual display, and has developed an artificial heart and lung for cardio surgery. Says Aronson: "As machinery builders and automation engineers, my partner and I have received many useful ideas and much guidance from the pages of AUTOMATION magazine. It stimulates all of us at Halm."

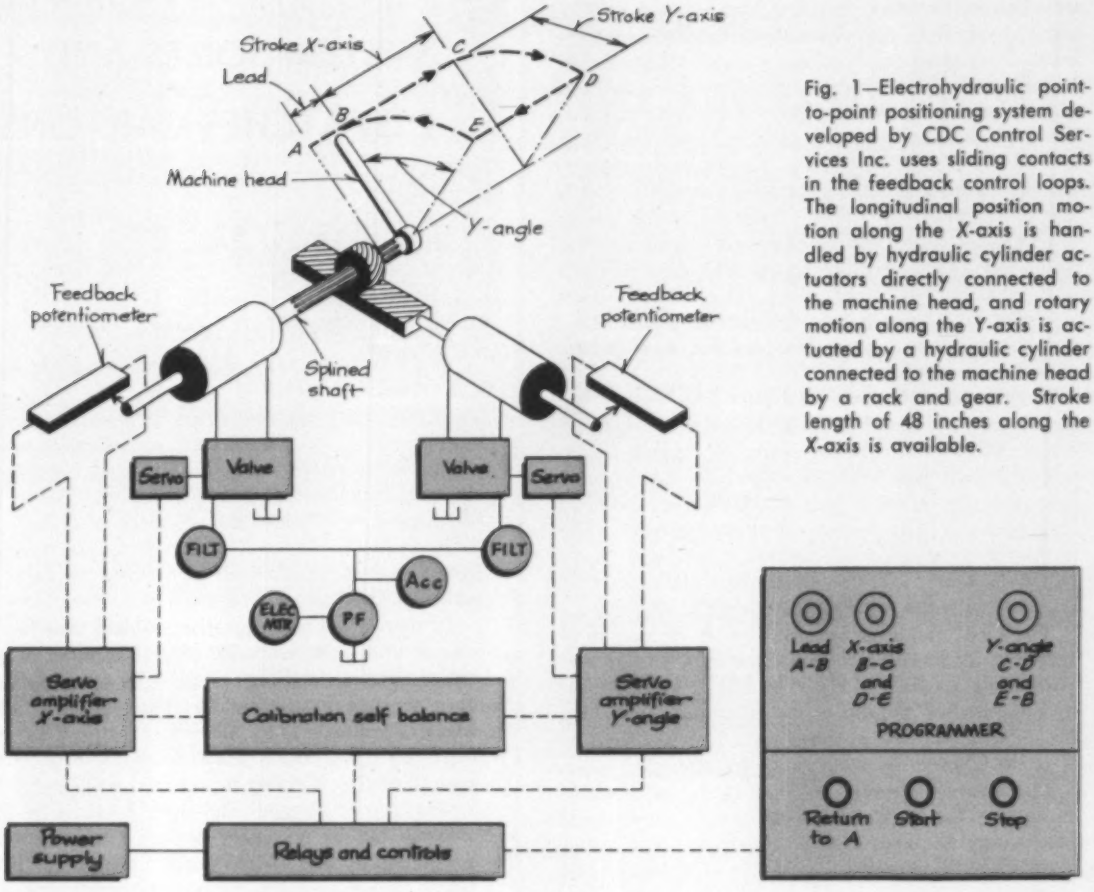


Fig. 1—Electrohydraulic point-to-point positioning system developed by CDC Control Services Inc. uses sliding contacts in the feedback control loops. The longitudinal position motion along the X-axis is handled by hydraulic cylinder actuators directly connected to the machine head, and rotary motion along the Y-axis is actuated by a hydraulic cylinder connected to the machine head by a rack and gear. Stroke length of 48 inches along the X-axis is available.

ELECTROHYDRAULIC POSITIONING DEVICE

ELECTROHYDRAULIC point-to-point positioning system for symmetrical, two-axis repetitive motion patterns has been developed by CDC Control Services Inc. The unique system can be profitably used in forming wire, tubing, or sheet into useful products, or in the automatic positioning of a machine head for punching, drilling, welding, inserting, or other operations.

The analog sliding contact type of positioning used in the CDC system has many advantages over other types of systems which determine absolute position by a switching contact type of device such as a digital sensor. Experience has shown that contact position systems present problems due to contact wear and dynamics. Any high speed precision control system must include a modulated sensing of the tool or material approach to the desired position. Analog techniques provide consistent modulation and minimize contact wear by substituting sliding feedback potentiometer contacts for relay contact closures.

The CDC positioning system, *Fig.* 1, is a simplified analog type with no *Make-Break* relay contacts in the control loops of the electrohydraulic positioning units. The few relays used outside the control loops are hermetically sealed. High performance positioning is accomplished by electrohydraulic servo systems actuating hydraulic cylinders which move the machine head along each axis. For positioning along the X-axis, a servo amplifier in the control loop electrically compares the command signal from the programmer with the positional signal from the X-axis feedback potentiometer. The servo amplifier then amplifies the error between the programmer command and the positional feedback signal and

provides an electrical signal to the servo valve. The valve ports oil to the hydraulic cylinder so as to reduce the position error signal to zero. This action causes the cylinder piston to move the machine head along the *X*-axis. At the same time, or subsequent to the movement of the machine head along the *X*-axis, the *Y*-axis servo loop causes the *Y*-axis hydraulic cylinder to move its piston in accordance with the programmed command. The rod of this piston is connected to a rack which causes a gear to rotate about the *X*-axis, moving the machine head through and arc along the *Y*-axis. Since the gear is connected to the *X*-axis piston rod by means of a splined shaft, the *X*-axis piston rod is free to slide through the gear to attain its programmed position.

Electrohydraulic positioning was selected for use in this system due to its reliability and because, using an accumulator, hydraulic power is capable of developing peak power for short periods of time with low horsepower requirements. Fifty times normal horsepower can be exerted for short intervals. The hydraulic pump produces necessary operating power for the system, and the accumulator also serves to prevent surge during high speed operations.

The CDC single or two-axis system is capable of speeds of 0.2 second to 1 second per basic motion and positioning accuracy of 1 part in 1000. The unit can be programmed by any of the commonly used data inputs such as dials, punched card, punched tape, or a curve-follower in contour programming.

The electrohydraulic positioning device used in this system has been widely employed in wind tunnel positioning; dynamic testing of airframes and accessories; and in operating high inertia dampers and butterfly valves in air test facilities, compressor surge prevention, and general industrial applications requiring dynamic performance. Due to its high resolution and its inherent proportioning action, the device constitutes an essentially "hard" system, approaching and attaining a new position in almost a deadbeat manner. For example, a movement of only $\frac{1}{4}$ inch can be accomplished in less than $\frac{1}{3}$ second, or 48 inches within one second, with no subsequent motion occurring once the desired position is attained by the machine head.

In its simplest form, the system handles repetitive and symmetrical motion patterns. For example, it has been applied to a machine for making three different rectangular motor windings, each having the same *X*-axis dimension and different *Y*-axis dimensions. This was accomplished by adding two additional *Y*-angle dials to the control panel (to attain two additional *Y*-axis dimensions) and by installing three dial-operated count limiters to control the number of turns in each motor winding. Stroke along the *X*-axis is governed by setting the *Lead* dial and the *X*-axis *Stroke* dial. The three *Y*-angle dials govern three successive index angles with common centerlines which determine position along the *Y*-axis. Manual switches and signal lights were added to permit program interruption and resumption as required. Adjustable velocity limits designed into the system made it possible to reduce the speed on the first two strokes with automatic resumption of maximum speed thereafter.

SYSTEM SORTS AND DISPATCHES CARTONS

By R. B. FRODGE
In Charge, Unit Conveying Div.
Fairfield Engineering Co.
Marion, Ohio

COSTS do not end when a product is assembled and packaged. After packaging the product must be transported to a warehouse or a shipping area. Where a number of styles or sizes of products are involved, this handling function can be quite expensive since mixed packages do not lend themselves to efficient warehousing practices. Also it is usually impractical in such situations to provide complete individual handling systems for each style or size of product.

In more cases than not, the problem thus becomes one of finding a means for several varieties of product to share a handling system. An automated solution to such a problem has been installed at the Major Appliance Div., General Electric Co., where a variety of products must be transported from a manufacturing building to a central warehouse. The system was engineered and built by Fairfield Engineering Co. to segregate packaged kitchen ranges according to size, align similar ranges in 30-foot trains, and dispatch the trains of ranges on a single conveyor with at least 30 feet between trains.

Four categories are handled—ranges for internal storage in the manufacturing building; 30-inch ranges; 40-inch ranges; and miscellaneous items. Ranges are delivered to the system in any sequence, at any spacing, and at a maximum rate of nine units per minute. In order to save valuable floor space, the system is located overhead.

A belt-driven live-roller conveyor, a type well suited for accumulation purposes, is used to feed packaged ranges into the system, *Fig.* 1. The cartons feed from this conveyor to a series of chain-driven live-roller conveyors. These conveyors are operated at different preset speeds to establish the capacity of the system and release cartons to the segregation area at a predetermined rate with at least a minimum gap between cartons. In the segregation area the cartons are classified by measuring their length with a limit switch arrangement. At the time the photograph for *Fig.* 2 was taken, the cartons were classified by a battery of photoelectric cells which sensed types of cartons by a reflected light method. Though this arrangement was satisfactory, it was changed when the warehousing methods were revised.

After the classification of each carton is sensed, it is directed to one of four powered roller conveyors. Cartons to be stored in the manufacturing building are allowed to pass straight through the segregation area for movement to the manufacturing storage area. Cartons in the three categories to be sent to the central warehouse are selectively transferred to one of

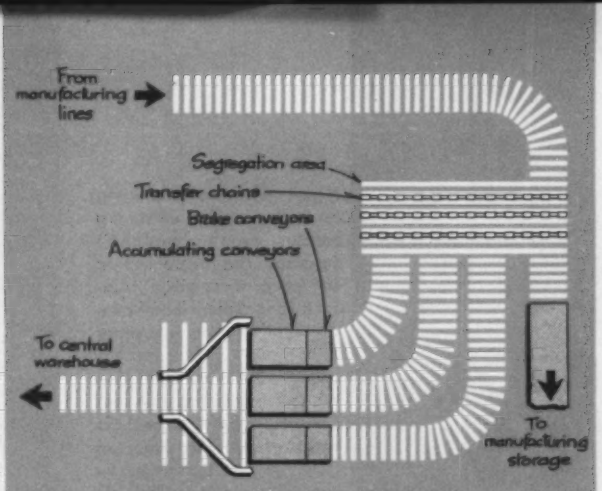


Fig. 1—Sketch illustrates automatic system to receive four intermixed categories of packaged products from manufacturing operations, sort them, gather three categories into trains for controlled release to a single conveyor to a central warehouse, and direct the fourth category to another conveyor leading to a manufacturing storage area.

three parallel conveyors. Transfer chains rise under a carton, lift it from the live-roller conveyor, and move it laterally until it is in line with the entrance to the proper line. The transfer chains are then lowered to deposit the carton on live-rollers which carry it onto one of three storage conveyor arrangements. Time cycles are such that the chains are lowered before the next carton moves into the transfer area.

Each of these three conveyors has a live-roller section which makes a 90-degree turn and brings the cartons to a short belt conveyor that serves as a brake or gate to control the flow of cartons to an accumulating conveyor. *Fig.* 3. A limit switch is used to commit the cartons from the brake conveyor to the accumulating conveyor. The accumulating conveyor is started and stopped by the limit switch to closely pack the cartons on this conveyor and build up a 30-foot train of cartons. When a full train of cartons has been accumulated, the brake conveyor is stopped. The train of cartons is automatically fed from the accumulating conveyor to a conveyor leading to the central warehouse.

The three accumulators feed cartons onto a single, wide, live-roller conveyor provided with deflectors which channel the cartons onto the conveyor to the warehouse. An accumulating conveyor is not discharged to the warehouse conveyor until there is a gap of 30 feet behind the preceding train. Interlocks and protection are provided to avoid jams in case the conveyors to the central warehouse are not operating or are not functioning properly.

After a train has left an accumulator, the brake conveyor for that accumulator is again started, and the accumulating conveyor is indexed to gather another train. The roller conveyors ahead of the brake conveyors have sufficient capacity to handle the normal loads occurring during the dispatching operations so that supply operations are not delayed.

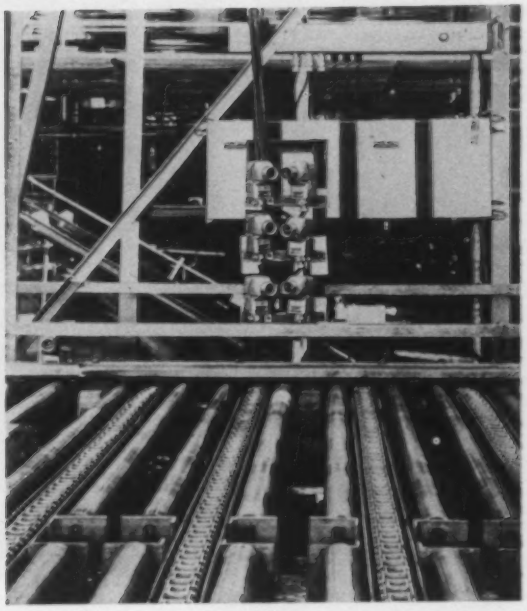


Fig. 2—Close-up of segregating area shows conveyor chains which can be raised to move a carton laterally above roller conveyors and then deposit it in line with the desired outgoing conveyor. The photoelectric cells and light sources used at the time of this photo to classify cartons were replaced in a revision of warehouse practices by a limit switch system which measures carton length.

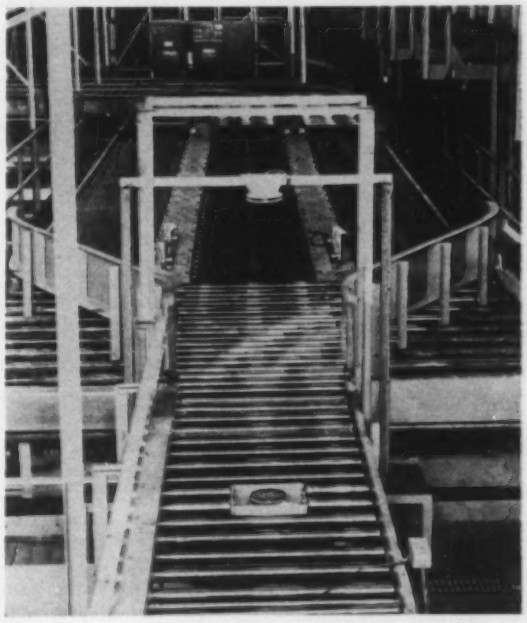


Fig. 3—Three categories of cartons to be discharged to a single conveyor are individually stored on the roller conveyors which turn 90 degrees in the background of this photo. Discharge from each storage conveyor to an accumulating belt conveyor is controlled by a short belt conveyor. When a 30-foot train of cartons is gathered on an accumulating conveyor it is automatically discharged to the central warehouse conveyor under control of system interlocks.

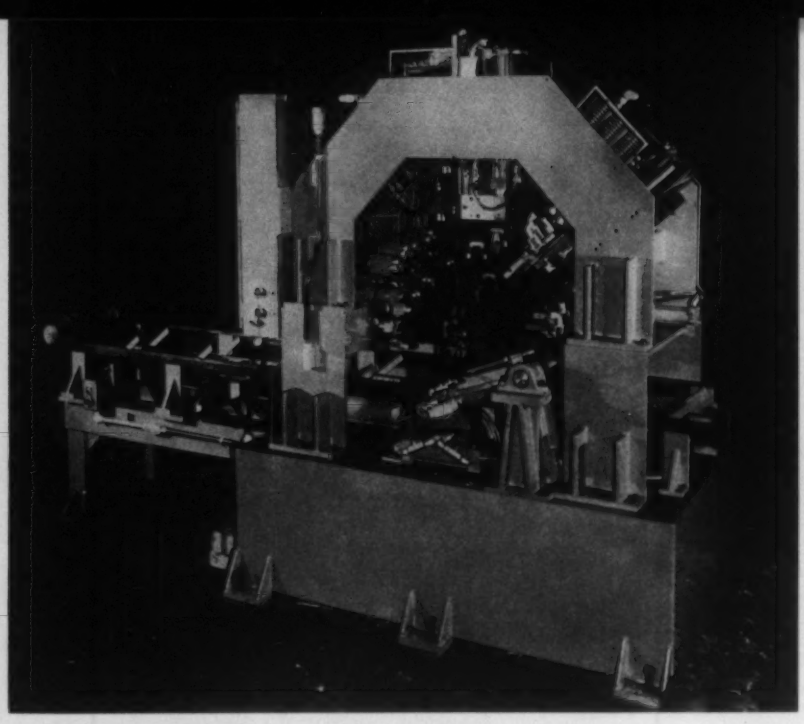


Fig. 1—Prior to machining in automated turning lathes, rough crankshaft forgings are inspected in this preprocess gage to insure that dimensionally incorrect parts do not enter the machining stations. Excessive stock on a forging causes faster tool wear, slower production, and increased unit costs. Rejected forgings are machined at separate stations on the manufacturing line.

AUTOMATIC

INTEGRATES

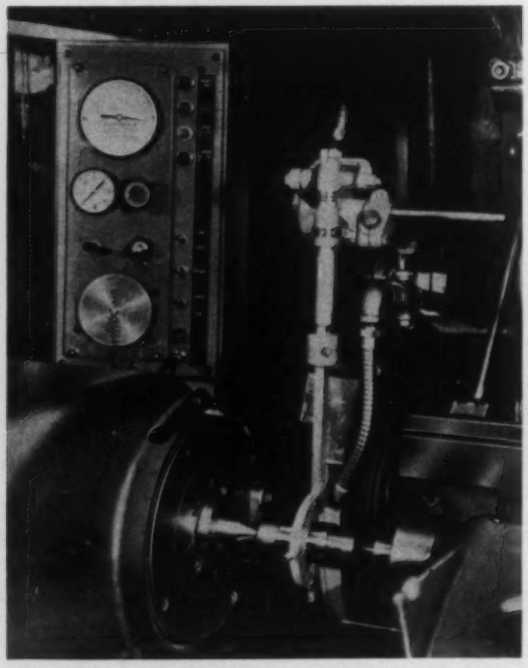


Fig. 2—Caliper inprocess gage member measures a part during grinding and pneumatically transmits size information to a control unit on the left. Control device furnishes signal to change infeed from fast to slow or to stop infeed for sparkout. At finished size, control causes grinding wheel to retract.

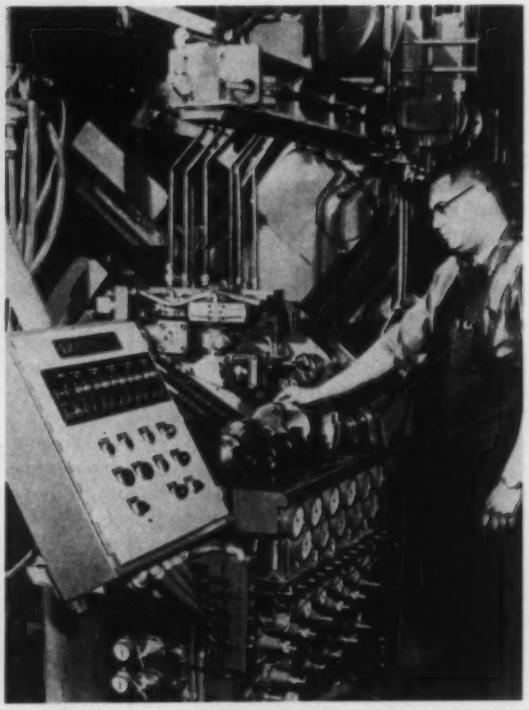


Fig. 3—Located adjacent to a crankshaft lathe, this Sheffield Corp. postprocess gage checks the diameters of the main crankshaft bearings and stops the lathe if any dimension is out of tolerance.

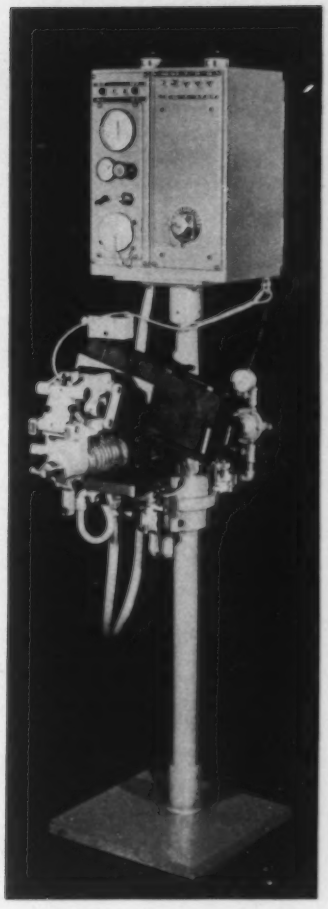


Fig. 4—Interchangeable tooling and an adjustable gaging station enable this portable postprocess gage to handle a wide variety of part shapes and sizes. This unit is designed to check a single dimension on a part after machining, and other units are available for checking two or more dimensions.

Control of production operations by precision gaging assures greater productivity, better quality products, and maximum use of machine capabilities. Function and application of gaging devices and machines are discussed in this article.

CONTROL GAGING

PRODUCTION LINES

AUTOMATIC CONTROL of machining, inspection, and assembly by precision measurement control gaging has become an essential element in attaining automation of production lines in all types of industries. The application of automatic control to machinery has been made possible by the development of small, compact, reliable measurement devices capable of controlling dimensional size at every stage of manufacture of a product. Today, many of these useful devices are standard items, suitable for installation in machining and gaging setups of user's own design.

Automatic control gaging in production processes initiates signals and actuating impulses to: 1. *Reject* before machining parts that are oversize or undersize. 2. *Control* part size during machining. 3. *Warn* when size trend is changing from specified tolerance. 4. *Advise* when tool adjustment or replacement is needed. 5. *Stop* machines producing offsize parts. 6. *Classify* and segregate parts by sizes for assembly to predetermined clearances.

Practically any dimensional or spatial relationship can be inspected automatically. Common examples of dimensions gaged daily in industry by automatic devices are internal and external diameters, length, depth, taper, and out-of-roundness. Automatic gaging is also applied to geometrical conditions such as parallelism, concentricity, and center distance.

Gage Function

Automatic gaging devices and systems are usually referred to by their function or position in the manufacturing process. Common locations for gages are: 1. Preprocess—inspection before machining. 2. In-process—inspection during machining. 3. Postprocess—inspection after machining. 4. Final inspection. 5. Assembly. Combinations of these gages may be used to provide automatic control over dimensional size from the moment a part enters the manufacturing process until it leaves as a finished product.

Preprocess Gaging: Part is inspected, before moving to a machining station, for either excessive or insufficient machining stock and for location and condition of machining area. This type of gaging helps to avoid damage to the machine or tooling, eliminates spending machining time on parts with insufficient stock, cuts down tool wear, and assures that only good parts are presented to the machine tool. A preprocess gage that inspects rough crankshaft forgings for excessive or insufficient stock be-

Fig. 5—Postprocess gage inspects the output from 20 grinding machines and feeds back signals to adjust or stop any one of the 20 machines which produces an out-of-tolerance part. Each part is checked for three dimensions at a rate of 1600 parts per hour, and parts are automatically segregated as acceptable or into three separate reject classifications.

fore machining is shown in *Fig.* 1. This and all other gaging installations illustrated use products of the Autometrology Div., Sheffield Corp.

Inprocess Gaging: Part is inspected while it is being machined. Gage measures the part during metal removal and indicates when the part is oversize, near size, and at final size. It supplies signals to automatically warn, adjust, or correct for tool or machine wear when size trend is changing from specified tolerances. Part shape, type of machining, cutting tool, method of chucking, and the machine's ability to use the gaging signals determine the type of inprocess gaging to be used. An inprocess gage that checks the outside diameter of parts during grinding is shown in *Fig.* 2.

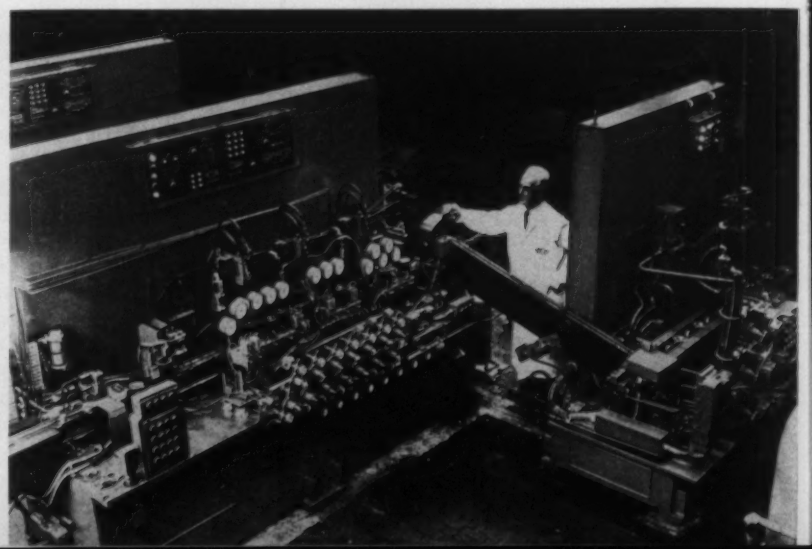
Postprocess Gaging: Part is inspected after forming or turning, and signals are fed back to the producing machine to warn, adjust, or shut down the machine if faulty parts are produced. Automatic classification and segregation of parts by dimensional size is often featured with this type of gaging. The postprocess gage, *Fig.* 3, receives crankshafts from an automated crankshaft turning lathe, gages several diameters simultaneously, and sends a signal to stop lathe if any dimension is out of tolerance.

A recent development in postprocess gaging is the standard pedestal-type unit, *Fig.* 4, which can be used to inspect a single dimension on a part after machining and to segregate it as either acceptable or a reject. It is usually located adjacent to the producing machine, and parts are gravity fed into and through the gage station. The gage utilizes interchangeable tooling, enabling it to perform precision inspection over a wide range of internal and external diameters, widths, tapers, and other part configurations. The standard unit can be provided with the following: 1. Signals to stop the producing machine when a predetermined number of consecutive rejects are gaged. 2. Feedback signals for machine compensation when the size trend varies toward minimum or maximum size limits. 3. Signals to segregate rejected parts into salvageable and nonsalvageable classes. 4. Signals to classify satisfactory parts by dimensional size.

Using a single postprocess gage to inspect the output of a number of machines reduces inspection costs. When the single gage supplies feedback signals to correct or stop any of a number of individual machines from producing faulty dimensions, even greater economy and better quality control may be achieved. A multiple machine gage that receives, from 20 grinding machines, two different size parts having several common dimensions is shown in *Fig.* 5. Parts are inspected and automatically segregated into acceptable or reject classifications. The gage "remembers" which machine produced the out of tolerance dimension and feeds back signals to the operator to adjust or shut down the machine. Signals can be integrated into the machine's circuit for automatic adjustments.

Final Inspection Gaging: Part is inspected after several different machine operations have been performed on it, and part is classified or segregated according to type of fault located. For example, a final inspection gaging machine inspects automotive piston pins for length, diameter at both ends, taper, and out-of-roundness and segregates them

Fig. 6—Final inspection gaging machine inspects automobile connecting rods at a rate of 1500 per hour. Rods enter on the left and are first checked for the weight at each end. Crankhole is then inspected for diameter, taper, and out of roundness. Crankhole diameter is classified in one of two size groups and stamped with ink. Rod is further checked for pinhole diameter, classified into one of three sizes of pinhole, and then crankhole and pinholes are checked for parallelism and center distance. Rods rejected for "bend" are passed to rod straightening machine on right and struck with a hydraulic hammer. After four cycles of gaging and striking, rods are rejected finally if still out of tolerance.



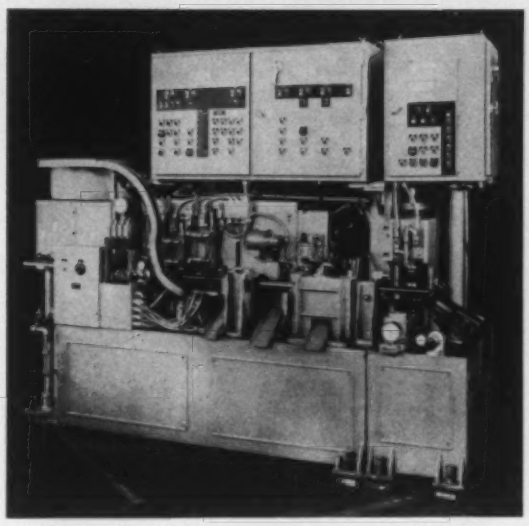


Fig. 7—Machine assembles taper roller bearings automatically. Preassembly gage station selects correct roller size and signals proper hopper to release 18 rollers to assembly station. Postassembly gage classifies and segregates assembly into either good or one of three reject classifications for noise, torque, or standout as bearing leaves machine.

into one of six diametral size classifications at a rate of 3000 pins per hour. Another type of final inspection gaging machine, *Fig.* 6, is used to inspect several dimensions and conditions on automobile connecting rods, reject bad ones, mark parts for selective assembly, and straighten bent rods.

Assembly Gaging: Part is inspected prior to assembly to another part or parts. Accurate automatic assembly depends upon the ability of parts to fit together quickly and easily. To ensure this, preassembly gaging stations in an assembly machine check parts before assembly. Postassembly gaging stations are also used on automatic assembly machines to final inspect the finished product, and, where desired, to classify and segregate the assembly as it leaves the machine.

Both types of gaging stations are used on the automatic taper roller bearing assembly machine, *Fig.* 7. The preassembly gage checks the diameter and flange thickness of the inner race to determine the correct roller size to be assembled within a given range. The gage then feeds a signal to one of six preselected size hoppers to release 18 rollers to the assembly station where race, rollers, and cage are assembled into a bearing of predetermined tolerance. After assembly, the bearing is checked at a second gage station under a revolving load condition for torque, noise level, and standout—the distance the back face of the cone extends from the cup. Bearings are segregated as acceptable or into reject classifications of noise, torque, or standout.

▶ Monitoring Devices

Other electronic devices can be used to keep tabs over automatic production. One portable device known as the Autometrolog, *Fig.* 8*a*, plugs into a gage amplifier circuit and computes and plots average and range for groups of successive gage readings at fast speeds. Average and range points are then plotted in the form of a continuous X and R

Fig. 8—Monitoring of automatic production lines can be aided by these two instruments. The Autometrolog (a) computes the average and range of any series of gaging operations. The Monitorecord (b) is used to check the timing of critical sequences in an automatic machine. Operator can tell at a glance what adjustments should be made to bring the machine up to maximum efficiency.

chart. This information can be used to forcast effective tool life, enabling tool changes to be made before part trend is out of tolerance. A machine's operating characteristics and capabilities can also be determined over a period of time.

Another instrument for use with automatic production and inspection equipment is called the Monitorecord, *Fig.* 8*b*. It is a portable electrical time recording instrument that records on a strip chart the beginning, duration, and end of a sequence, and shows the relations of the sequence to other sequences and to an over-all time cycle. A standard model will monitor up to 14 separate operations simultaneously. After an operation sequence has been recorded, the operator compares the chart against a plastic master chart to determine whether each sequence is operating at peak efficiency.

Automatic dimensional inspection is progressing from a separate and off-line process to an integrated part of the production line providing continuous "built-in" quality control at every stage of machining and manufacture. Like many other fields associated with the concept of automation, automatic gaging fills one more gap in the trend toward the automatic manufacturing line producing finished products from raw materials without manual intervention.

AUTOMATIC MACHINE REPLACES MANUAL PARTS PACKAGING

PACKAGING of small parts can be a tedious, expensive, and time-consuming operation when performed manually. In addition to the material cost of envelopes, labor must often be provided to mark the packages for identification of parts, to count and insert parts into each package, and to seal and count the finished packages. Airesearch Mfg. Div., Garrett Corp., solved their small parts packaging problem by installing an automatic packaging machine manufactured by Product Packaging Engineering. This machine makes and prints its own bags, automatically feeds parts into and heat seals the bags, cuts the bags apart from a continuous web, and counts the individual bags—at speeds up to 6000 units per hour. Installation of the new packaging equipment has provided better packages, more efficient use of personnel, and faster delivery of spare parts to customers.

Bags are formed on the packaging machine, *Fig.* 1, from two rolls of coated or laminated heat sealable material. A lower roll feeds through the machine on a horizontal plane and forms a web conveyor on which parts to be packaged are deposited. An upper roll feeds past a printing head and then around a heat sealing roller which positions the upper web over the part and the lower web. Both webs then pass between heat sealing rollers and are sealed together on four sides. Each roller has a cutout center which contains the part during sealing. After sealing, the webs are cut apart by cutoff blades to form the individual parts packages. Heat sealable materials that can be used on the packaging machine include polyethylene-coated kraft, kraft foil vinyl, polyethylene-coated cellophane and Mylar, and heat sealable cellophane.

Three different systems of feeding parts to the lower web are provided on the machine. Small unmanageable parts which would ordinarily roll or shake off the packaging web are fed from an upper 8-position rotary turntable. The unit rotates and drops the parts into a chute which feeds them directly between the heat sealing rollers as the bag is formed. A lower rotary turntable is used for ordinary parts. In this feeding device, parts are rotated over the lower web of the heat sealing material. A cam causes a sleeve to rise, and the lower web conveys the part between the heat sealing rollers. The third method of feeding is by vibratory hopper. This unit is attached in-line with the travel of the lower web and feeds parts individually or in groups onto the web. A timing device controls the spacing of parts on the web by releasing them at spaced intervals.

Airesearch Mfg. Div. is a manufacturer of small gas turbines, pressurization equipment, valves, and systems and components for military and commercial aviation. When rush orders for small parts were processed in the past, shipping personnel often had to be removed from other assignments in order to help process the orders. This in turn slowed down other shipping schedules and delayed deliveries in some cases. With the installation of the new machine, regular spare parts personnel can handle volume orders of small parts expeditiously without interrupting other shipping schedules.

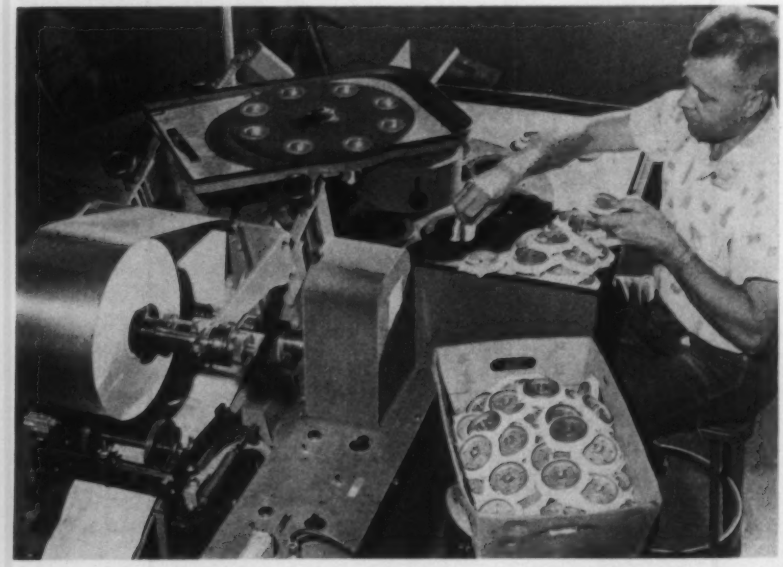


Fig. 1—Operator feeds parts into pockets of lower rotary turntable of an automatic packaging machine. Unit rotates and releases parts onto lower web of heat sealing material. Upper web of heat sealing material is printed with identifying parts data and is positioned over part and lower web. After passing though heat sealing rollers, sealed packages are cut into individual units. Smaller parts can be fed by means of upper rotary turntable or a vibratory hopper.

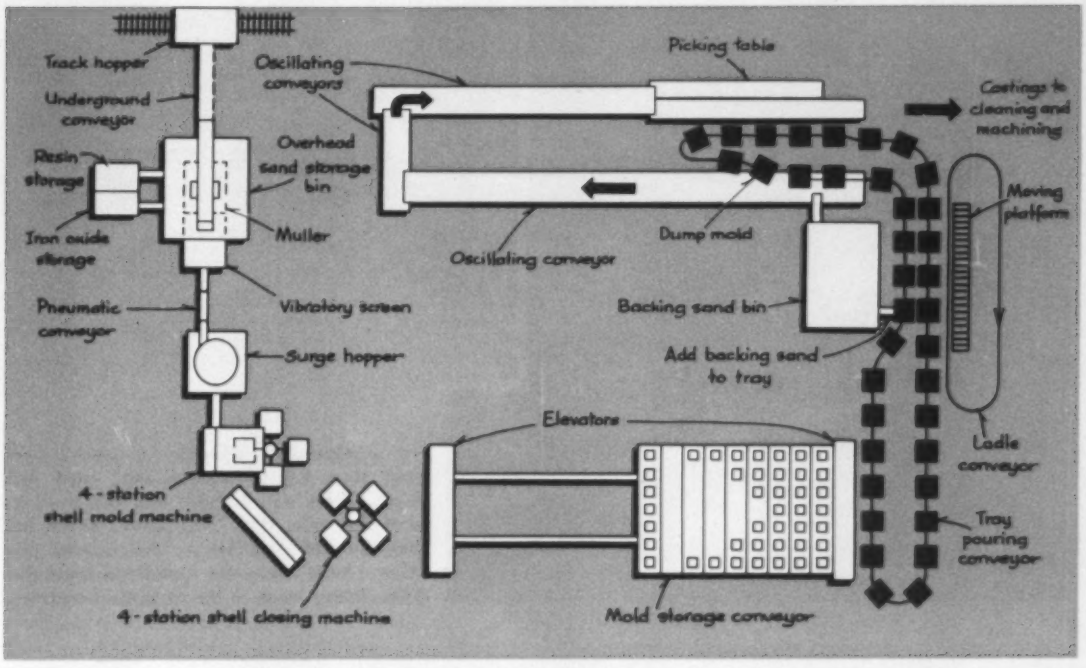


Fig. 1—Flow diagram of the mechanized shell mold foundry shows the integrated conveyor systems which automatically carry sand, shell molds, and castings through the process. An extensive system of ventilation and dust control hoods has been installed over the foundry units to control cleanliness.

SHELL MOLD FOUNDRY MECHANIZED BY CONVEYOR SYSTEMS

A HIGHLY MECHANIZED shell mold foundry has been built by Evinrude Motors Div., Outboard Marine Corp., to produce steel crankshaft castings for outboard motors. Previously made by forging, the new process reduces the amount of steel used in each crankshaft and eliminates some subsequent machining operations. In addition, the castings are of more closely controlled metallurgical quality than the forgings previously used.

Designed jointly by Evinrude Motors and Link-Belt Co., the foundry contains integrated handling systems, *Fig.* 1, which automatically process sand from the railroad cars to the shell molding machinery and carry the completed shell molds through storage, pouring, shakeout, and cooling until finished crankshaft castings emerge from the end of the line. Heart of the process is an automatic Link-Belt four-station shell molding machine which can produce a thin shell mold of resin-bonded sand every 15 seconds.

Foundry sand is received in hopper gondola cars, discharged into a track hopper, and automatically conveyed into a two-compartment storage bin above the foundry floor. Each compartment is fitted with a bottom measuring hopper which discharges a predetermined amount of sand into a muller. Resin and iron oxide are delivered from other storage hoppers by screw conveyors, weighed by automatic scales, and discharged into the muller. An alcohol-water solvent is added to the muller for the cold coating of sand mix. The automatic process can provide 2000 to 2500 pounds of coated sand mix per hour.

The sand mix is discharged from the muller, screened, and conveyed pneumatically to a surge hopper at the four-station shell molding machine. At the first station a water-jacketed flask is lowered onto the combined drag and cope pattern and is automatically filled with a measured amount of resin-coated sand. This adheses to the heated pattern and fuses to form a shell mold of the desired thickness. Excess sand mix is discharged by rolling the pattern and flask over. The machine then in-

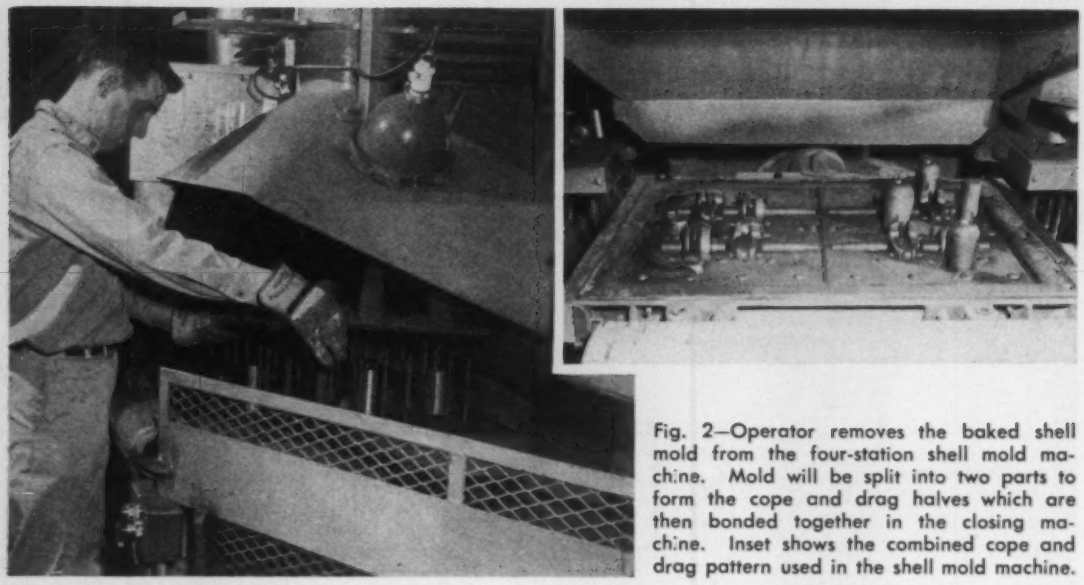


Fig. 2—Operator removes the baked shell mold from the four-station shell mold machine. Mold will be split into two parts to form the cope and drag halves which are then bonded together in the closing machine. Inset shows the combined cope and drag pattern used in the shell mold machine.

dexes through two successive curing stations where the shell is baked under electric heaters until the desired hardness is obtained. At the fourth station, *Fig.* 2, the finished shell is stripped from the pattern, split into drag and cope halves, and transferred to the shell closing machine.

After the insertion of cores, adhesive is applied on the drag half, and the cope is placed face-down on the drag in the closing machine. An air-operated mechanism in the four-station closing machine holds the two halves together until the adhesive sets. After removal from the closing machine, the shell molds are placed on a mold storage conveyor having a capacity for 832 molds. The molds are stored upside-down in 52 carriers.

Carriers holding sixteen molds each are elevated automatically to either of two storage tiers. On the discharge end of the conveyor an elevator lowers the carriers to working level. After inspection, the molds are placed on pouring conveyor trays filled with 1½ inches of backing sand. The overhead conveyor carries the molds past the pouring area where an operator, standing on a moving platform, ladles molten metal into the molds.

Poured molds continue on the conveyor to shake-out stations where the trays are automatically tipped, discharging the contents on an oscillating conveyor. Three successive oscillating conveyors break the mold from the casting, screen out mold and backing sand, and deliver the cooled castings to a picking table. An operator segregates the casting from the sand, refuse, and scrap metal, and the casting is delivered into wire baskets. After the sprues and gating systems are removed by a cutting saw, the castings are shot blasted and loaded into trays for normalize and draw operations.

are you stuck?

In the past few years AUTOMATION has helped in the solution of hundreds of widely diversified practical problems in making operations more automatic. Regardless of the character of the operation or system being developed, somewhere in industry a similar problem has been solved and, very often, equipment is available or suitable techniques are known.

Development can be simplified, engineering costs reduced, and reliability guaranteed with tried and proved equipment and devices available today for achieving successful automation. Whether the problem is simple or complex, practical or technical, the Editors will be pleased to help find the right answer. The vast reservoir of industrial know-how is yours for the asking. Take advantage of this service. Write to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio.

Developing and building new machines from the ground up for numerical control applications can be prohibitively expensive. A practical alternative to this costly approach is possible when suitable standard machines are available. Application of numerical control for small-lot operations on jig borers has proved worthwhile by this alternate approach.

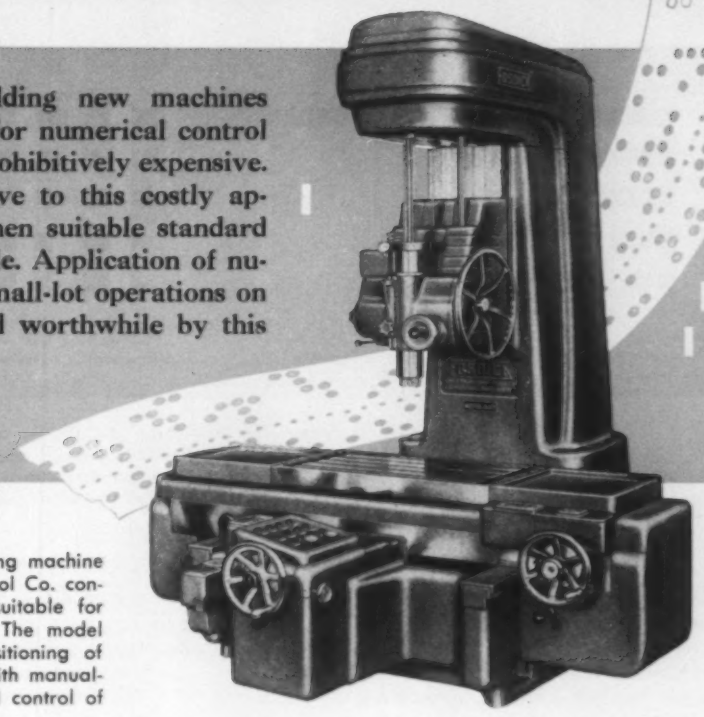


Fig. 1—A standard model jig boring machine available from Fosdick Machine Tool Co. contains built-in features making it suitable for conversion to numerical control. The model shown incorporates automatic positioning of table and saddle in accordance with manually set dials and provides electrical control of spindle feeds and speeds.

STANDARD MACHINE CONVERTED FOR

NUMERICALLY CONTROLLED JIG BORING

TAKE a suitable basic machine, add numerical control to the degree justifiable, and reap the benefits of automated production. This philosophy has been attractive to many prospective appliers of automation. But users of jig borers have often felt this philosophy only applied to other types of operations.

Fosdick Machine Tool Co. can show that this feeling is erroneous. They make standard jig borers which are manually controlled; but if the user's production conditions warrant, they can add numerical controls in degrees of complexity to match the level justified. This has been demonstrated by their having built such equipment in co-operation with various users. These machines have reached levels of automation in which tools are automatically changed on command, besides incorporating automatic positioning, automatic control of spindle feeds and speeds, and automatic control of hole depth.

In a standard Fosdick jig borer, *Fig.* 1, the workpiece is clamped on a table. This table moves on ways to give longitudinal positioning from side to side under the spindle. These table ways are on a saddle which moves toward or away from the spindle column to give transverse positioning of the workpiece. The spindle head moves up and down on the column, and the spindle feeds up or down in the head.

All of these motions can be controlled by manipulation of pushbuttons; and the table, saddle, and head can also be clamped in position by electric switch command. Speeds and feeds of the spindle are determined by selective actuation of magnetic clutches in the spindle gear box. Gears are constantly in mesh and no sliding gears, shifting forks, or mechanical linkages are required. Sixteen speeds and eight feeds can be electrically selected from the control station.

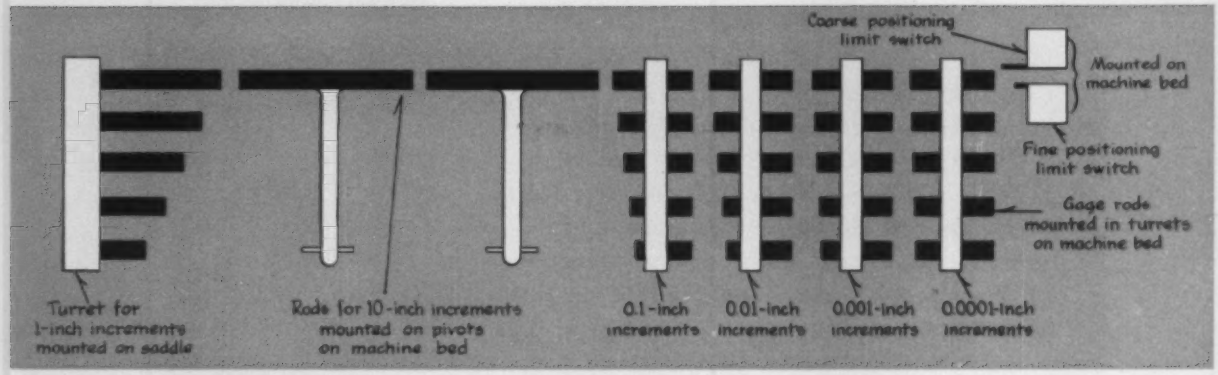

Coarse positioning limit switch
Mounted on machine bed
Fine positioning limit switch
Gage rods mounted in turrets on machine bed
Turret for 1-inch increments mounted on saddle
Rods for 10-inch increments mounted on pivots on machine bed
0.1-inch increments
0.01-inch increments
0.001-inch increments
0.0001-inch increments

Fig. 2—Electromechanical system for positioning the saddle of the Fosdick machine is based on use of gage rods to establish desired displacements from a reference point. In the standard machine the operator turns dials to align the gage rods required for a desired position. Limit switches control the drive motors to reach the position.

Precise positioning of the work is obtained by moving the table and saddle to longitudinal and transverse positions which are established by measurements from reference points. These measurements are made for each direction by stacking the required assortment of gage rods between a point on the moving element and the actuators of sensitive limit switches, *Fig.* 2. The arrangement to locate the longitudinal position of the table is carried by the saddle, and the arrangement to locate the transverse position of the saddle is mounted on the bed of the machine.

Each of these measuring arrangements includes six dials which manipulate a series of gages manufactured to Class-A gage block accuracy. The gage rods are mounted on drums, or turrets, which can be rotated to bring the desired rods into alignment at the measuring point. One dial controls increments of 10 inches; a second dial controls 1-inch increments; and third, fourth, fifth, and sixth dials control increments respectively of 0.1000 inch, 0.0100 inch, 0.0010 inch, and 0.0001 inch. Setting these dials aligns the proper gage rods. When the button for longitudinal positioning is pressed, a rapid traverse motor turns a lead screw to move the table to within 1/16 inch of final position. This motion trips the coarse positioning limit switch and the precision positioning motor takes over. The table is closely

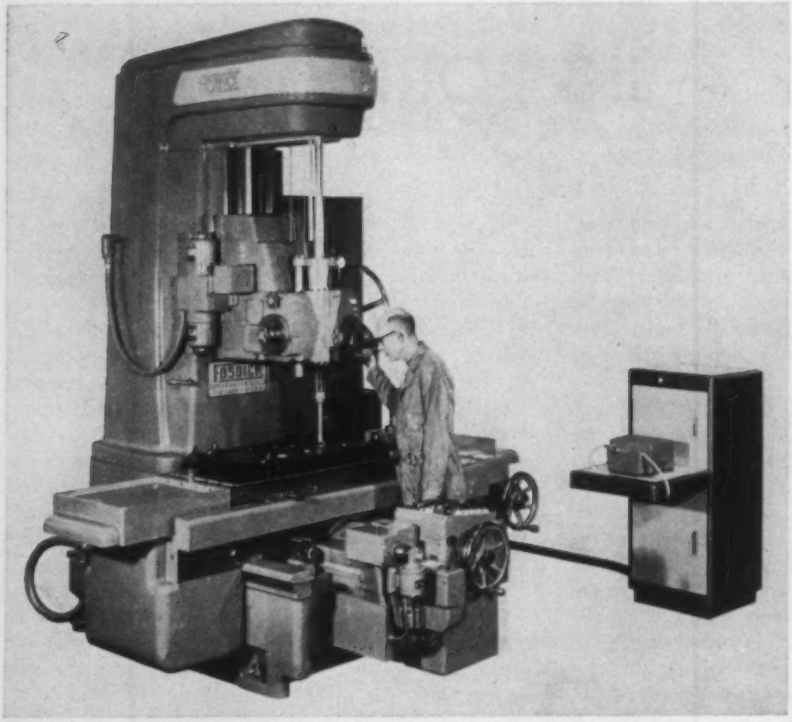
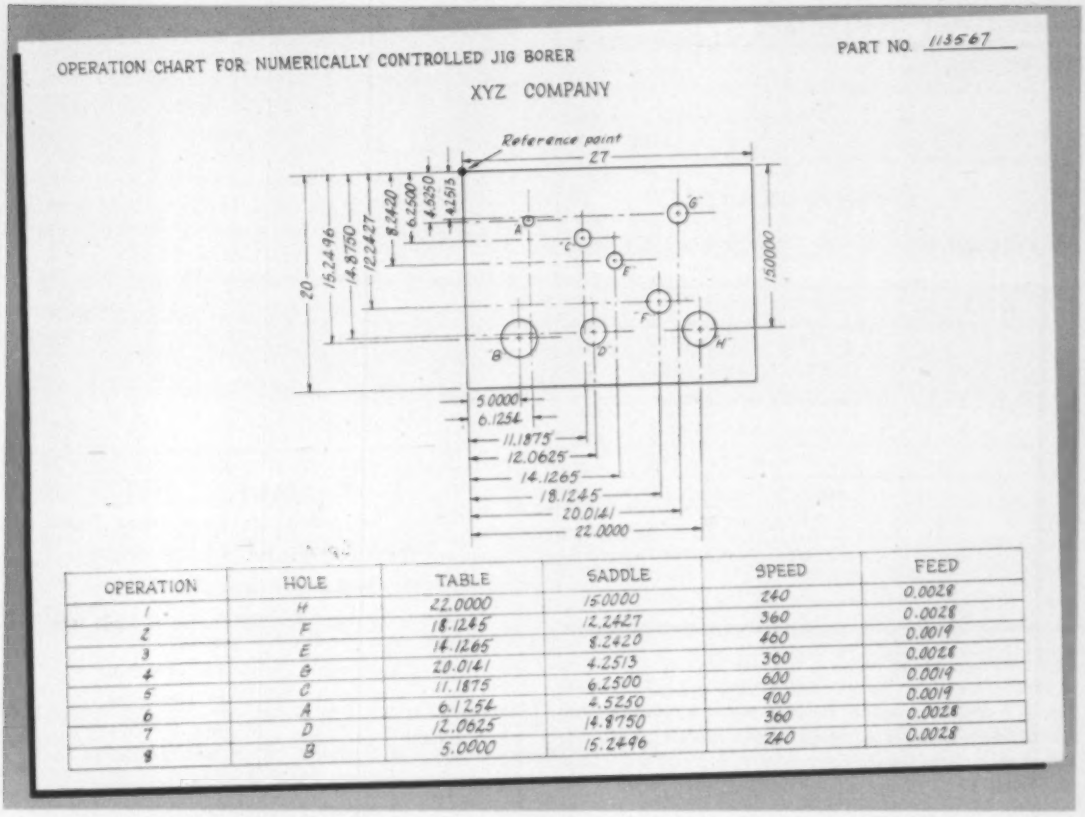


Fig. 3—This machine is one to which a tape reader and servo systems have been added so that positioning of the table and saddle and setting of spindle feeds and speeds is automatically performed from instructions punched in a tape.



OPERATION	HOLE	TABLE	SADDLE	SPEED	FEED
1	H	22.0000	15.0000	240	0.0028
2	F	18.1245	12.2427	360	0.0028
3	E	14.1265	8.2420	460	0.0019
4	G	20.0141	4.2513	360	0.0028
5	C	11.1875	6.2500	600	0.0019
6	A	6.1254	4.5250	900	0.0019
7	D	12.0625	14.8750	360	0.0028
8	B	5.0000	15.2496	240	0.0028

Fig. 4—Operation chart for part which might be run on the tape controlled jig borer. Drawing gives table and saddle settings from a reference point to desired hole centers. Spindle feeds and speeds and sequence of operations can be fixed by the engineering group which prepares the operation chart.

positioned and the fine positioning limit switch is tripped. This action reverses the positioning motor for a prescribed number of revolutions to relieve the drive train, and the table is then within 0.0001 inch of the designated longitudinal position. Transverse positioning of the saddle is accomplished in the same manner, and may be carried out while the table is being positioned longitudinally.

▶ Numerically Controlled Functions

Because the basic machine includes an accurate built-in measuring system and electric control of major functions, it is not difficult to visualize possible use of numerical control to direct this jig borer. Five basic functions of this jig borer have been numerically controlled and such control of these functions has been recommended in the order in which they follow.

Table and Saddle Location: Servo systems can be installed to automatically set the dials which align the position measuring rods. With such a system the table will automatically proceed to the position commanded. Even with numerical control of only this function a great deal of time can be saved and the table can reach its new position before the operator finishes changing tools. Operator errors in positioning can also be eliminated, reducing scrap losses and improving quality.

Spindle Feeds and Speeds: Electrically stepped switches can replace the manual selector switches which determine the spindle feed and speed. These settings can be rapidly and accurately changed to specified values. Accurate adherence to properly specified feeds and speeds ensures the production of holes with required finish and accuracy of hole diameters.

Spindle Feed Depth: The depth to which the spindle is fed can be numerically controlled by adding an arrangement to sense the advance of the tool. This sensing arrangement can provide for the automatic shift from rapid feed advance to cutting feed advance when the cutting tool nears the surface of the work. The spindle can then be fed into the work to the prescribed depth, its feed and rotation stopped, and the spindle retracted.

Spindle Head Height: Since the distance which the spindle can advance from the head is limited, the height of the spindle head must be adjusted for large differences in the heights of work surfaces. This function, too, can be automatically performed

MACHINE INSTRUCTIONS

XYZ COMPANY PART NO. 113567

OPERATIONS	CONTROL INSTRUCTIONS
1	a2200006150000c204d
2	a181245b122427c404d
3	a141265b082420c503d
4	a200141b042513c404d
5	a111875b062500c613d
6	a061254b045250c713d
7	a120625b148750c404d
8	a050000b152496c204d

Fig. 5—These alpha-numeric expressions record the instructions for each hole in the sample operation chart, *Fig.* 4. Each expression includes the commands for table position, saddle position, spindle speed, and spindle feed. Expressions are determined by reference to TABLE 1.

by adding to the electrical controls of the basic machine. Such a system will eliminate the need for the determination by the operator of what head positions are required to reach all holes in the part with the spindle travel available.

Tool Changing: With the addition of required mechanisms and controls, these jig borers can incorporate automatic changing of tools. The borer is then capable of automatically completing intermixed operations of drilling, boring, reaming, counterboring, and tapping with a variety of tools.

Tape Controlled Machine

One example of the application of numerical control to a jig borer is a tape controlled machine, *Fig.* 3, built for the Aircraft Gas Turbine Div., General Electric Co. In this machine a punched paper tape stores the commands for positioning of the table and saddle and for the spindle feed and speed.

Tapes are prepared in the engineering department. Proper speeds and feeds to achieve desired finishes and hole diameters are determined by cutting specialists; dimensions for hole locations are taken from the part prints; and the order in which operations are to be performed is determined to give the most efficient production sequence. This information may be assembled on an operation chart such as shown in *Fig.* 4.

Using a reference sheet, TABLE 1, the instructions for each hole can be translated into a concise alpha-numeric expression. Expressions for each of the eight holes specified in *Fig.* 4 are shown in *Fig.* 5. Each expression gives complete information for the automatic positioning of the table and saddle and for the setting of spindle feed and speed. For this tape controlled machine, these expressions are recorded one character at a time by use of a Commercial Controls Corp. automatic tape-punching typewriter. Each character is recorded in the form of a pattern of holes in a single line across an 8-channel paper tape. The completed tape is inserted in a tape reader at the machine when the job is to be run.

Tools are set in the toolroom and numbered according to the program recorded on the operation

TABLE 1
19-Step Sequence for Expressing Table, Saddle, Speed, & Feed Instructions

Step	Symbol	Meaning
(1)	a	Beginning of table information
(2)	1 through 4	10-inch increments
(3)	0 through 9	1-inch increments
(4)	0 through 9	0.1-inch increments
(5)	0 through 9	0.01-inch increments
(6)	0 through 9	0.001-inch increments
(7)	0 through 9	0.0001-inch increments
(8)	b	Beginning of saddle information
(9)	1 or 2	10-inch increments
(10)	0 through 9	1-inch increments (Must not exceed 3 if 2 is specified for 10-inch increments)
(11)	0 through 9	0.1-inch increments
(12)	0 through 9	0.01-inch increments
(13)	0 through 9	0.001-inch increments
(14)	0 through 9	0.0001-inch increments
(15)	c	Beginning of speed and feed information
(16)	0	30 or 60 rpm
	1	45 or 90 rpm
	2	120 or 240 rpm
	3	150 or 295 rpm
	4	180 or 360 rpm
	5	225 or 460 rpm
	6	600 or 1200 rpm
	7	900 or 1800 rpm
(17)	0	High speed
	1	Low speed
(18)	0	0.0005 ipr
	1	0.0008 ipr
	2	0.0012 ipr
	3	0.0019 ipr
	4	0.0028 ipr
	5	0.0040 ipr
	6	0.0070 ipr
	7	0.0100 ipr
(19)	d	Completion of instruction

"EL" or "End of Line" punch in tape may be used to provide spacing

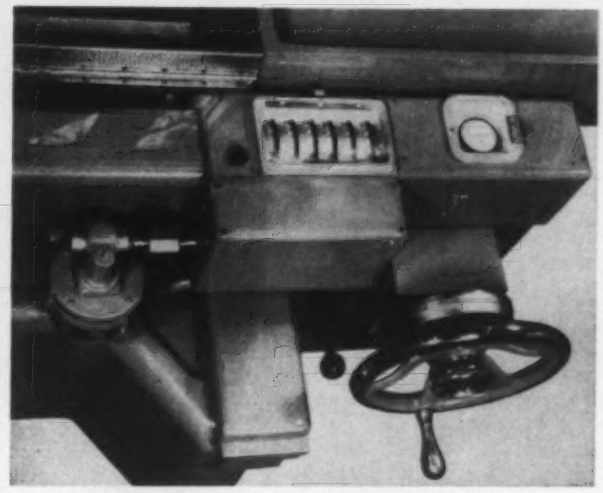


Fig. 6—Compact servo system shown as added to table position control of standard machine in tape controlled unit. A similar system was added to the saddle position control.

chart. After the part is loaded and the proper tool mounted on the spindle, the operator presses a button. The instruction is read out from the tape, and the table is automatically positioned and the spindle feed and speed automatically set.

Automatic positioning in accordance with punched tape commands was made possible in this machine by adding servo systems to automatically manipulate the locating dials. *Fig.* 6 shows the motor and control box added to set the dials for longtitudinal positioning. The motor provides shaft rotation to move the dials; electrically controlled clutches selectively engage and disengage the dials; and commutators and brushes serve to report the positions of the dials. A similar addition was made to set the dials for transverse positioning.

The flow of information is from the tape to a temporary information storage system in which stepping switches are positioned to represent the tape commands. The stepping switches then control the positioning of the dials that manipulate the gage rods.

When the dials have been set for a given operation, the stepping switches can be repositioned in accordance with the next set of instructions on the tape. The switch system will thus be ready to reposition the dials as soon as the machining operation is completed.

Automatic control of the spindle feed and speed was incorporated by use of stepping switches which also are stepped by signals from the tape reader. These stepping switches determine which clutches are energized in the feed and speed gear box.

Cost of tape control of longitudinal and transverse positioning on this machine is about $15,000. This would be in addition to the price of the standard machine. Inclusion of tape control of spindle feed and speeds adds another $2500. These investments can be rapidly amortized by savings in setup and machining times, reduction in jig and fixture costs, and reduction in inventory costs.

▶ Card Controlled Machine

Another example of the application of numerical control to a jig borer is a machine, *Fig.* 7, owned by International Business Machines Corp. This machine incorporates automatic control of saddle and

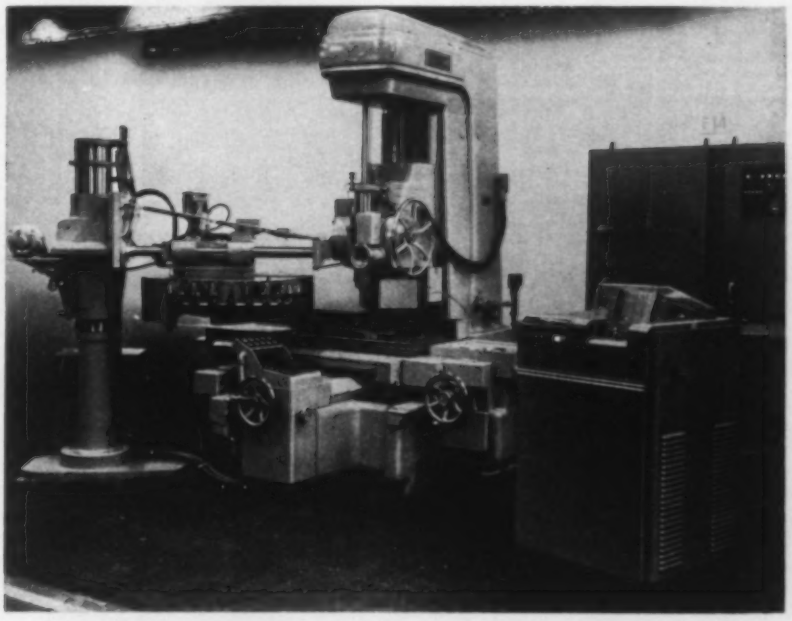


Fig. 7—In addition to automatic positioning of table and saddle and automatic setting of feeds and speeds, this card controlled jig borer includes automatic tool changing and automatic depth control. Tools to be used are stored on the periphery of a circular index device supported by the auxiliary column at left.

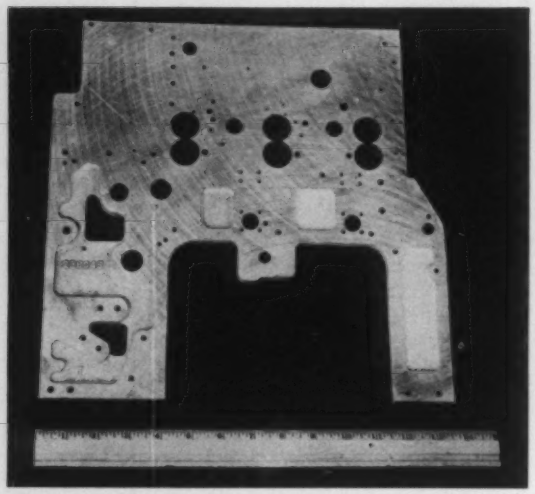


Fig. 8—Typical part to be run on the card controlled machine indicates variety of hole sizes and spacings which may be required on parts run in small lots. The numerically controlled borer can produce holes located within 0.0001 inch with hole depths held within 0.002 inch.

table positions, spindle feed and speed, spindle feed depth, and tool changing. It is used in the production of side frames for IBM data processing equipment. Such frames, *Fig.* 8, may be required in small lots with some thirty holes of various diameters and depths. Accuracy of location within 0.001 inch and accuracy of hole depth within 0.002 may be required.

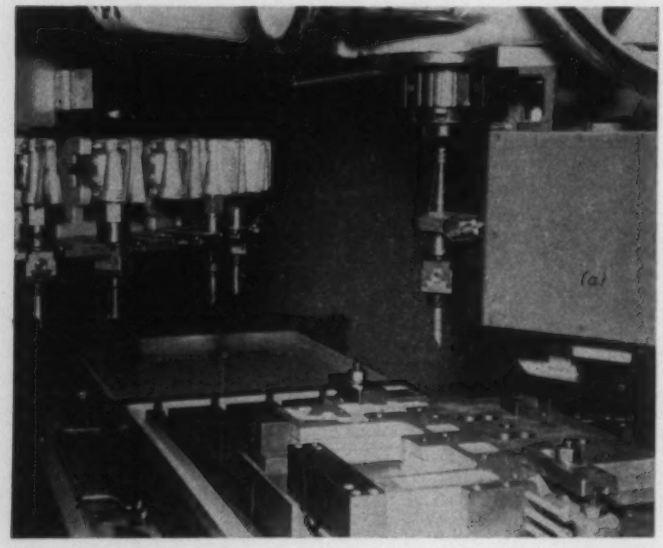
Instructions for this machine are prepared in much the same manner as for the tape controlled machine, but the complete command for each hole is recorded on an individual punched card. The instruction for each hole must specify longitudinal table position, saddle position, tool to be used, spindle speed, spindle feed rate, depth of feed, and whether or not the boring operation is to be repeated.

A deck of cards specifying the operations to be performed on a workpiece is placed in a card reader with the cards in proper sequence. The tools to be used are placed in an automatic tool changing arrangement from which a desired tool can be selectively withdrawn. After the operator clamps the workpiece in position and presses a button, the machine can automatically complete the boring of all the holes specified.

Tool Changing

Each of the tools to be used in the automatic tool changer is mounted in a tool holder that has a tapered shank with a straight external thread at the top of the taper and a large hex section at the bottom of the taper. These external threads and tapers will mate with an internal thread and taper in the spindle. Each boring tool is set for diameter in the tool room and numbered. The machine operator places the numbered tool holders in an index plate, or matrix, which stores them at the machine.

This matrix is a circular unit with 30 positions around its periphery at which tool holders may be stored. Each tool holder is supported by the edges of a slot in the plate and held in position by spring loaded clamps. The index plate can be rotated automatically to swing any desired tool position toward



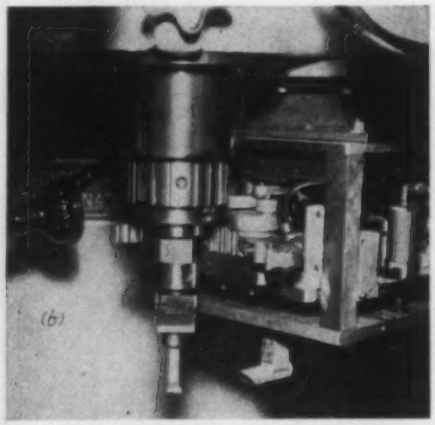
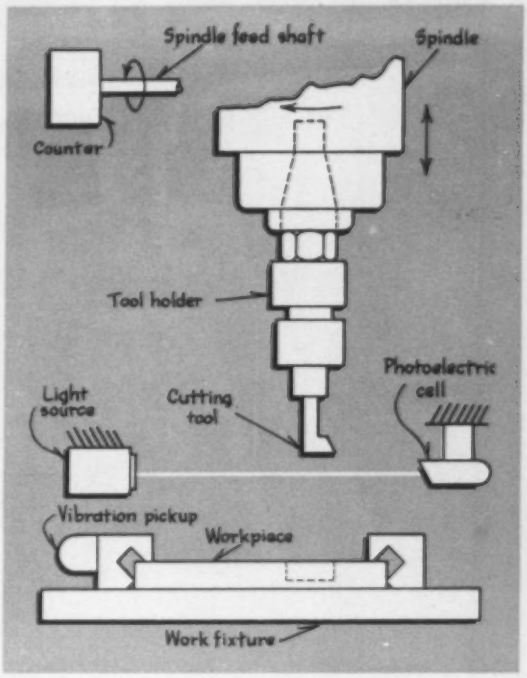


Fig. 9—Tools are transferred between the index storage plate and the machine spindle by an automatic jaw mechanism. At *(a)* the index plate is shown at left while the jaws hold the tool in position for the spindle to descend and screw onto the threads on the tool holder. In *(b)* the cover has been removed to show the jaw mechanism with the jaws open and the spindle free to carry the tool down into the workpiece.

Fig. 10—Sketch indicates arrangement for automatic control of depth to which the cutting tool is fed. The photoelectric system is used in changing the feed rate from rapid advance to cutting feed. The vibration pickup senses when actual cutting begins and the feed shaft counter determines when desired depth has been reached.



the machine spindle. The pivot for the index plate is supported from above by a head which slides on two round bars toward or away from the machine spindle. By rotation of the index plate and advance of the plate toward the spindle, a selected tool position can be brought under the spindle.

A jaw mechanism mounted near the spindle grips the hex section of the tool holder which has been positioned and holds it while the index plate or matrix is retracted away from the spindle, *Fig. 9a*. Feeding the spindle down at slow speed engages the threads on the tool shank and seats it in the spindle. When a preset locking torque is reached, the jaw mechanism opens and retracts, *Fig. 9b*. The spindle is then free to feed down into the work. After the operation is completed and the spindle retracted to the level of the jaw mechanism, the steps just described are reversed, and the tool holder is returned to the storage position on the matrix.

▶ Feed Depth Control

The downward feed of the spindle for each operation is controlled by use of two sensing arrangements, *Fig.* 10. A photocell senses the arrival of the point of the tool at a predetermined height above the work surface and, after a preset number of revolutions of the feed shaft, the spindle feed is shifted from rapid advance to cutting feed advance. A vibration pickup senses the start of the actual cutting, and the number of spindle feed shaft revolutions after that time is a measure of the depth reached.

Use of the photoelectric system allows automatic change from rapid advance to cutting feed when the tool point is a preset distance from the work surface, regardless of tool length. This means that it is not necessary to hold the length of all tools to a single precise measurement, and it is not necessary to waste time by shifting to slower feeds at a spindle height determined solely by the longest tool to be used.

Sensing of the start of actual cutting is based on the fact that a work-holding fixture on a machine is subjected to two general levels of vibration. One level is that occurring when the machine is running but no cutting tool is removing material from a workpiece. The second level occurs when a cutting tool is removing material from a workpiece. A piezoelectric crystal mounted on the fixture is sensitive to a change from one level of vibration to the other. An electric signal is obtained when such a change in vibration occurs, and subsequent counting of feed shaft revolutions indicates when the tool should be retracted.

Many other configurations of numerical control systems can be applied to standard basic machines of suitable design such as this jig borer. Besides punched paper tape and punched cards, a punched Mylar tape four inches wide has been used with a Hillyer tape reader. Preference has been expressed in many cases, however, for the 1-inch wide, 8-channel punched paper tape.

With a control system suited to the particular application, automatic control of versatile machines holds out real opportunities in reduction of manufacturing cost, improvement of quality, and attainment of other manufacturing goals in the short-run production of parts.

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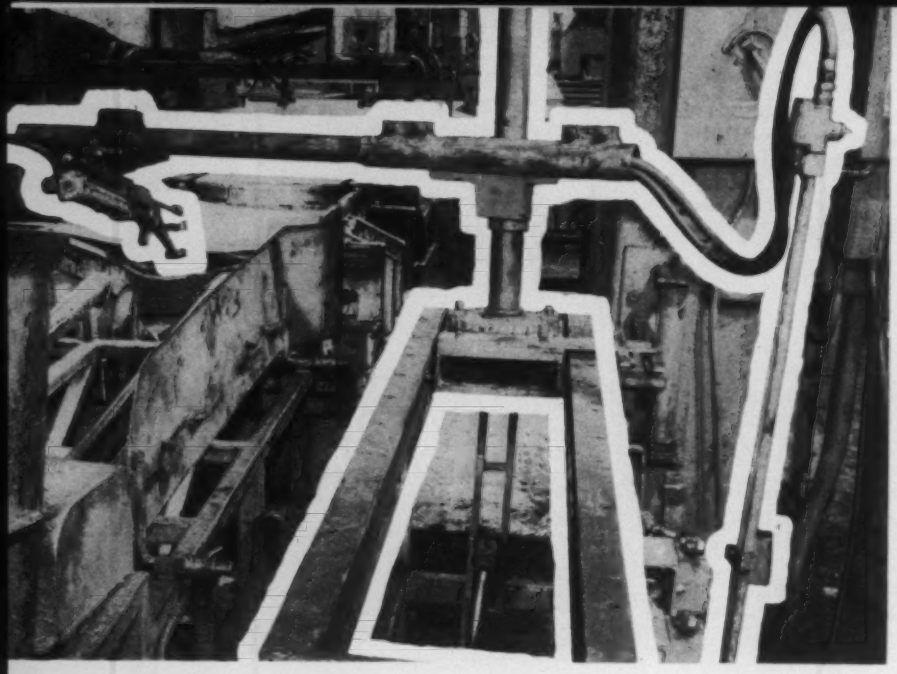


Fig. 1—Pneumatically operated press extractor advances toward a stamping press, grips a part and takes it out of the press during the press opening stroke, and retracts to complete its cycle. Jaws of gripping device open during the retracting stroke to release the part onto a conveyor or transfer device.

SPECIAL PNEUMATIC CIRCUIT PROVIDES

CONTROL OF MACHINE MASSES

By **WALTER D. LUDWIG**
President
Mechanical Air Controls, Inc.
Detroit, Mich.

RATE OF OUTPUT of a production line composed of machines that are connected interdependently in series is limited to that of the slowest machine in the line. Obviously, therefore, engineering effort to increase system output should first be directed toward improving the productivity of this least-efficient machine. In accomplishing this objective, however, a great deal of ingenuity and technical know-how must sometimes be brought to bear.

A recent experience of Mechanical Air Controls, Inc. engineers is a case in point. Called into the Dearborn Stamping Plant of Ford Motor Co., MAC engineers were asked to see what they could do to equalize the production rates of a group of pneumatically operated press extractors with those of the presses they serve. The press extractors are used to automatically remove automobile hood panels, body parts, and fenders from stamping presses. A discussion of this problem and its successful solution is of particular interest from the point of view

Smooth acceleration and deceleration of machine masses at rates that are predetermined by functional requirements can be easier to specify than to attain. Often, conventional pneumatic, electrical, or hydraulic technology fails to provide the means. In such cases it may be necessary to design a special control system that takes into consideration the machine dynamics involved.

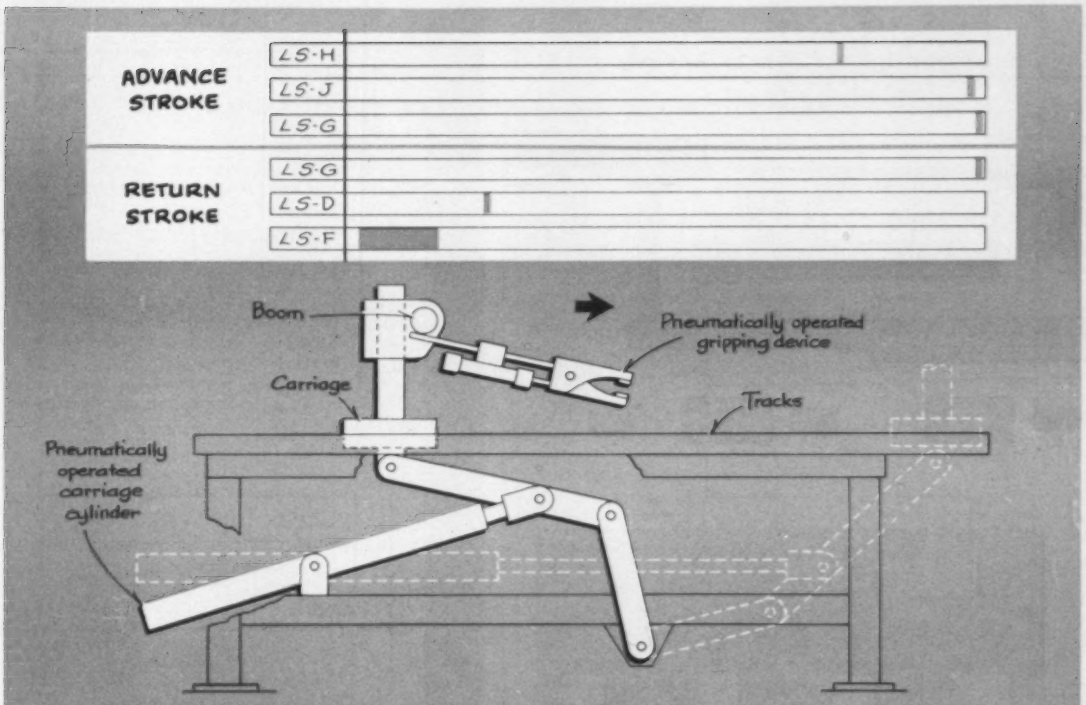


Fig. 2—Diagram illustrates basic mechanical details of press extractor. A 3¼-inch bore by 36-inch stroke air cylinder moves carriage a distance of 6 feet by means of a compound linkage. Smooth deceleration of machine masses at end of strokes, and rapid acceleration in return direction, are critical requirements. Chart shows carriage positions at which various limit switches are operated.

of the pneumatic and electrical control circuits, and a special pneumatic component, that evolved.

▸ The Problem

Stamping presses that have given output capabilities were being held to lesser production rates because of the slower operating cycles of accessory press extractors, *Fig.* 1.

The operating sequence of the press extractors is: 1. Advance a gripping device toward the press and dwell. 2. Grip the part during the press opening stroke. 3. Retract the gripping device to take the part out of the press. 4. Release the part to a conveyor or transfer device. 5. Retract fully and dwell.

Specifically, difficulty and loss of cycle time were being experienced in rapidly decelerating the moving elements at the ends of the press extractor strokes, and in accelerating them quickly in the return direction after the parts were gripped. Rapid acceleration in the return direction is particularly important because of the time available to extract the parts from the press.

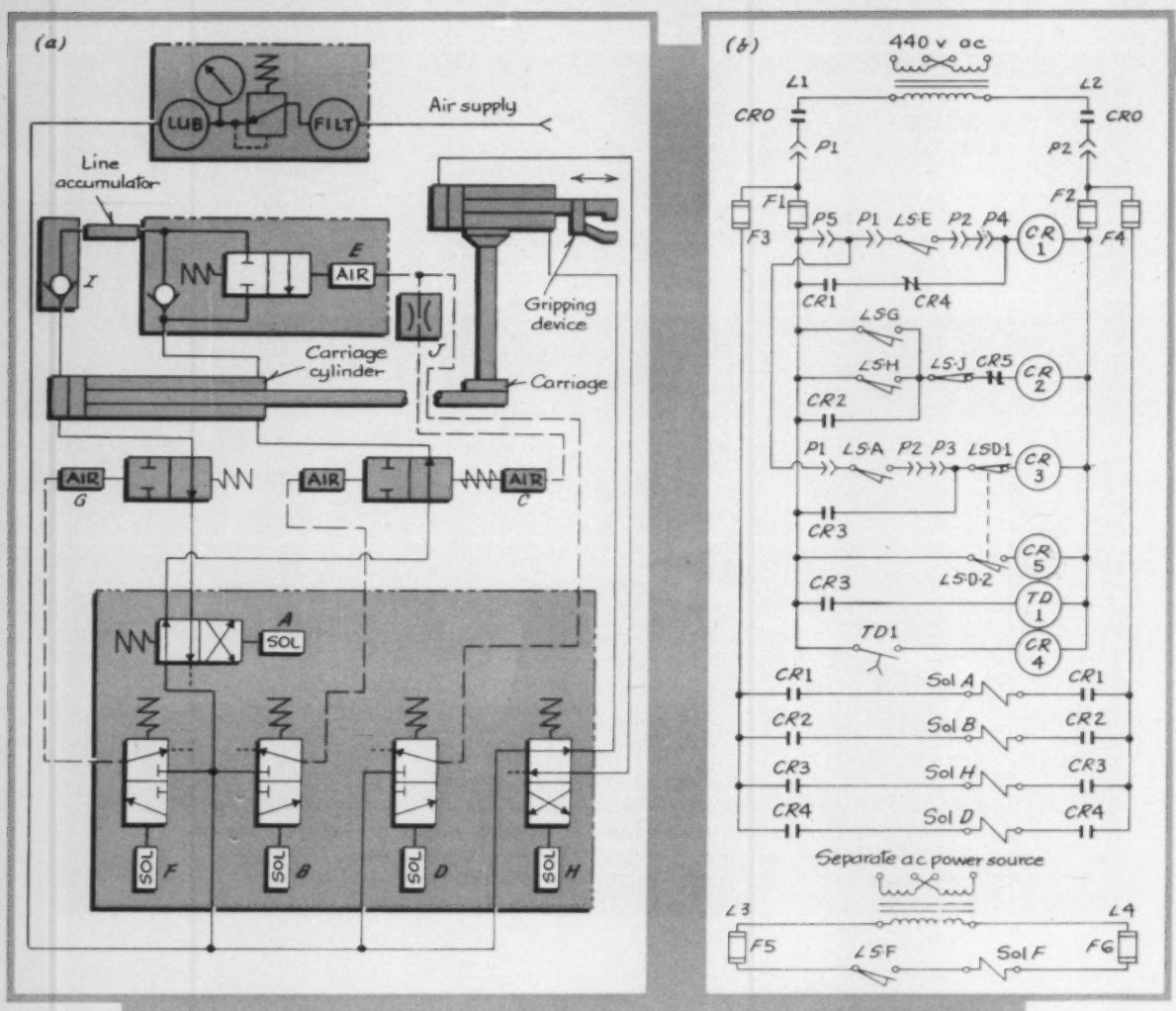
Mechanical details of a press extractor of the type used are diagramed in *Fig.* 2. The carriage, boom, and gripping device of this machine weigh 275 pounds. The weights of other moving elements, including an actuating piston, a piston rod, and a linkage, add to the total mass that must be controlled. In the return direction, weight of the part being removed is also a consideration

Acceleration of the machine elements and part in the return direction is complicated by an additional factor. When the extractor carriage is in its fully advanced position, the linkage configuration, *Fig.* 2, is such that the actuating cylinder is at a 3 to 1 force disadvantage in returning the carriage.

Briefly, then, the engineering problem confronting Mechanical Air Controls, Inc. engineers was: Devise means to rapidly decelerate the moving elements at the ends of the extraetor strokes, and increase the accelerating forces available from the actuating cylinder at the beginning of the return stroke. Supply air at 80 psi, available from shop air lines, could not be increased.

▸ The Solution

Both of the engineering objectives were satisfied by the development of an unusual pneumatic control circuit and an associated electrical control circuit, *Fig.* 3. By means of these control circuits, the re-



(c)

	Operation or Carriage Position	Pneumatic Valve Controls								Switches								Coils						
		A	B	C*	D	E	F	G	H	LSA	LSD -1	LSD -2	LSE	LSF	LSG	LSH	LSJ	TD 1	CR 1	CR 2	CR 3	CR 4	CR 5	TD 1
1	Startup condition																							
2	Begin advance stroke	■									■													
3	Decelerate and charge	■		■							■		■							■				
4	Complete advance stroke	■		■							■		■			■				■				
5	Lock in advance position	■		■							■		■			■	■			■				
6	Grip workpiece	■		■					■	■	■		■			■	■			■				■
7	Begin return stroke		■	■	■		■		■		■			■			■	■			■	■		■
8	Continue return stroke		■	■	■		■		■		■			■			■				■	■		
9	Release work piece		■	■	■				■			■					■				■			
10	Decelerate and charge		■	■	■			■	■		■						■				■			
11	Complete return stroke		■	■	■			■	■		■						■				■			

*Valve "C" is considered energized when its left hand pilot is operated with no pressure on its right hand pilot.

■ Energized or contacts closed

□ De-energized or contacts open

Fig. 3—Pneumatic circuit diagram illustrates components used, including specially developed line accumulator that functions as combined cushion and accumulator at ends of press extractor strokes (a). Electrical circuit diagram identifies limit switches and other control elements that determine operating positions of pneumatic valves (b). Sequence chart for pneumatic and electrical components shows interrelationships of control actions (c).

PNEUMATIC AND ELECTRICAL CONTROL ACTIONS

STEPS in the operation and control of the press extractor can be followed by reference to the pneumatic and electrical circuit diagrams and the sequence chart of *Fig.* 3*a*, *b*, and *c*.

Startup Condition. Initially, the carriage of the press extractor is held in its fully retracted position and no valve or electrical controls are energized. In this condition, supply air at 40 psi is acting on the rod end of the carriage cylinder through spring-loaded valves *A* and *C*. Pressure in the line accumulator is also 40 psi, since the check valve in valve *E* is free to open on rod end pressure.

Begin Advance Stroke. Normally open limit switch *LSE* is momentarily closed by downward motion of the press. This causes energization of the coil of relay *CR*1, which is held in by contacts *CR*1 and *CR*4 as long as relay *CR*4 is not energized. A pair of *CR*1 contacts closes on energization of relay *CR*1 and the solenoid of valve *A* is energized.

Resulting shifting of the spool of valve *A* directs air to the blind end of the carriage cylinder through valve *G* and the carriage advances. Exhaust from the rod end of the carriage cylinder is effected through valves *C* and *A*. Supply air pressure is maintained in the line accumulator.

Decelerate and Charge. When the rapidly advancing carriage reaches a position about 20 inches before the end of its stroke, normally open limit switch *LSH* is momentarily closed. A circuit is thus completed through *LSH*, normally closed limit switch *LSJ*, and the coil of relay *CR*2. This relay is energized and held in by a *CR*2 contact as long as limit switch *LSJ* remains closed and relay *CR*5 is not energized.

Operation of relay *CR*2 energizes the solenoid of valve *B* and the spool of this valve shifts. Supply air is thus admitted to the lefthand pilot of valve *C* and this valve closes. The sudden blocking of the exhaust path for the air in the rod end of the carriage cylinder causes this element to decelerate. However, through inertia of the moving elements, stopping is not effected immediately. Instead, the air in the rod end of the carriage cylinder is compressed and forced through the check valve in valve *E* into the line accumulator.

Complete Advance Stroke. When the smoothly decelerating carriage reaches a position 1-inch from the end of the advance stroke, limit switch *LSJ* is momentarily opened. This breaks the holding circuit of relay *CR*2 and this relay is de-energized. The resulting shifting of the spool of valve *B* provides a path for air to exhaust from the lefthand pilot of valve *C* and this valve opens under spring force. The purpose of this action is to exhaust the air remaining in the rod end of the carriage cylinder and thus allow a complete stroke. The air in the accumulator is maintained at an intensified pressure by the check valves.

Lock in Advance Position. At ½-inch from the end of the advance stroke the carriage closes *LSG*, which re-energizes *CR*2, operating valve *B*, admitting air to the lefthand pilot of valve *C*, causing *C* to close. The cylinder is thus locked in the advance position.

Grip Workpiece. Normally open limit switch *LSA* is next momentarily closed on the upstroke of the press, and the coil of relay *CR*3 is thereby energized. It is held in by contact *CR*3 bridging *LSA* as long as limit switch *LSD*1 is closed.

Two actions occur as a result of energization of relay *CR*3:

1. The coil of time delay relay *TD*1 is energized. This unit contains normally open contacts that close after a predetermined time delay period following its energization.

2. The solenoid of valve *H* is energized by the closing of *CR*3 contacts and air is admitted to the blind end of the gripping cylinder. The gripping jaws thus advance into the press and close on the workpiece.

Begin Return Stroke. After the predetermined time delay period for *TD*1 has elasped, the contacts in this unit close and energize the coil of relay *CR*4. Two actions occur as a result:

1. Normally closed *CR*4 contacts in the holding circuit of relay *CR*1 open and relay *CR*1 is de-energized. Thus the solenoid of valve *A* is de-energized and the blind end of the carriage cylinder is opened to exhaust through valves *G* and *A*.

2. *CR*4 contacts close in the circuit of the solenoid of valve *D* and the spool of this valve shifts to a position admitting air to the pilot of valve *E*. The same pressure is applied to the inlet port of flow control valve *J*, but does not result in immediate operation of the righthand pilot of valve *C* because of the resistance to flow offered by valve *J*. Thus, there is a short interval during which valve *E* is open and valve *C* has not yet opened. It is during this time that the high-pressure air contained in the line accumulator is applied to the rod end of the carriage cylinder through valve *E*. The resulting surge of power applied to the rod end overcomes static friction and the inertia of the moving elements, and the carriage is accelerated rapidly in the return direction.

As the carriage returns, limit switch *LSG* opens, but relay *CR*2 remains energized. A mechanical latching arrangement allows limit switch *LSJ* to be passed over without being tripped by carriage motion in this direction.

Continue Return Stroke. The design of flow control valve *J* is such that valve *C* will open by the time that the pressure in the rod end of the carriage cylinder drops to 40 psi. Supply air pressure at 40 psi then takes over through valve *C* to complete the retraction of the cylinder. It should be noted at this point that the design of valve *C* is such that it will be open when either the righthand pilot alone, both the righthand and lefthand pilots, or no pilots, are actuated. A spring feature that assists the righthand pilot in opening the valve makes this possible. Closing of this valve requires that the lefthand pilot be operated alone.

Release Workpiece. When the carriage reaches a position about 18 inches from the end of the return stroke, limit switch *LSD*1 is opened and relay *CR*3 is de-energized. This de-energizes the coil of timer *TD*1, its closed contacts open, and relay *CR*4 is released. The solenoid of valve *H* is de-energized when relay *CR*3 opens and the solenoid of valve *D* is de-energized as a result of de-energization of relay *CR*4.

Shifting of the spool of valve *H* causes the piston of the gripping cylinder to return, and the jaws of the gripping device open and release the part. Shifting of the spool of valve *D* connects the pilot of valve *E* to exhaust and the latter valve closes. The righthand pilot of valve *C* is also exhausted through flow control valve *J*.

As limit switch *LSD*1 is opened, limit switch *LSD*2 is closed. The latter action energizes relay *CR*5, contacts of this relay open, de-energizing relay *CR*2. Valve *B* thus shifts and releases the air from lefthand pilot of valve *C*. With both pilots of this valve exhausted, valve *C* remains open under spring force.

Decelerate and Charge. When the rapidly returning carriage reaches a position about 12 inches before the end of the return stroke, normally open limit switch *LSF* is closed. The solenoid of valve *F* is thus actuated and the spool of this valve shifts to a position admitting air to the pilot of valve *G*. Closing of valve *G* blocks the exhaust path for air in the blind end of the carriage cylinder and the line accumulator is again charged. Pressure in the accumulator builds up to 110 psi through check valve *I* and the carriage is decelerated smoothly.

Complete Return Stroke. Just before the carriage reaches its extreme return position, limit switch *LSF* is opened, the spool of valve *F* shifts, and the pilot of valve *G* is opened to exhaust. Resulting shifting of the spool of valve *G* opens the blind end of the carriage cylinder to exhaust and this cylinder is held positively in its return position by rod end pressure at 40 psi.

The press extractor is now ready to start another cycle with the line accumulator precharged to 110 psi. At the end of the next and all subsequent advance strokes this pressure will be increased to 160 psi.

quired press unloading rate is readily obtained with air supply pressure of only 40 psi.

Control actions for one cycle of the press extractor are described in the box accompanying *Fig.* 3. Reference to the pneumatic and electrical circuit diagrams and sequence chart, *Fig.* 3*a*, *b*, and c, will facilitate following these actions.

The key element that insures success of the new control scheme is a line accumulator made of a length of 1-inch diameter hose. This device is connected between a check valve mounted at a blind end port of the actuating cylinder and a control valve with integral check valve mounted at a rod end port of the cylinder, *Fig.* 4. Other ports at the ends of the actuating cylinder are used to admit and exhaust air to and from the cylinder, depending on the operating positions of close-coupled control valves.

The line accumulator replaces the conventional cushions which were removed from each end of the actuating cylinder. It functions as a combined cushion and accumulator at each end of the stroke of this cylinder.

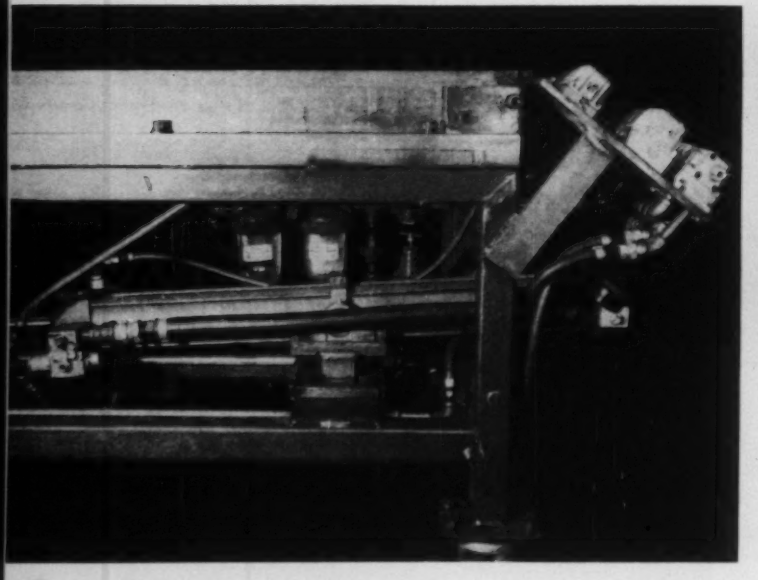
An example of this dual action occurs during the last part of the advance stroke of the extractor. When the rapidly advancing carriage of the unloader is in a position about 20 inches from the end of the advance stroke, a control valve in the rod end of the actuating cylinder is closed. This action blocks the exhaust path to atmosphere for air in the rod end. The forces of machine inertia and supply air pressure acting on the blind end of the cylinder then act to force the air remaining in the rod end into the line accumulator, where it builds up to a pressure of 160 psi. Smooth deceleration of the machine elements accompanies this action.

The air thus pushed from the cylinder into the line accumulator is trapped in the latter element by the check valves at each of its ends. After a dwell period of the extractor in its advance position, while the gripping device grasps a part, a control valve shunting the check valve in the rod end of the cylinder is opened. This allows the high-pressure air in the accumulator to enter the rod end of the $3\frac{1}{4}$-inch bore cylinder. The result is rapid acceleration of the machine carriage in the return direction. Supply air at 40 psi completes the return stroke.

To aid the buildup, the line accumulator is charged during the last portion of the return stroke of the extractor while the machine decelerates to a smooth stop. Accumulator pressure builds up to 110 psi in the return direction and is held by the check valves.

This project, involving as it did the development of special control circuits and a pneumatic component that is not available commercially, illustrates that original thinking and a great deal of engineering skill must often be applied in increasing the productivity of a critical line machine. A thorough understanding of machine dynamics and the techniques of automatic control was essential in this particular case.

Reclaiming of the energy of the moving machine elements when they are decelerated, in the form of air under pressure in the line accumulator, contributes to economy of air consumption of the press extractor. This, and the reduction of primary air supply pressure from 80 to 40 psi that was effected, refute the old saw that compressed air is necessarily a wasteful medium for powering machines.



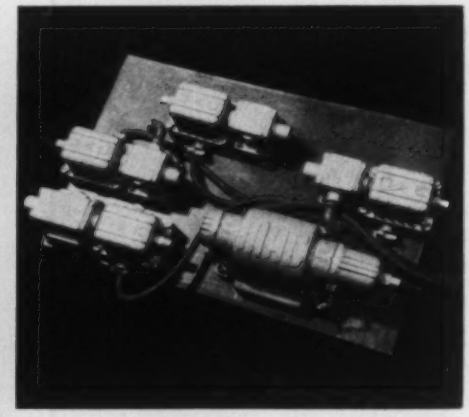
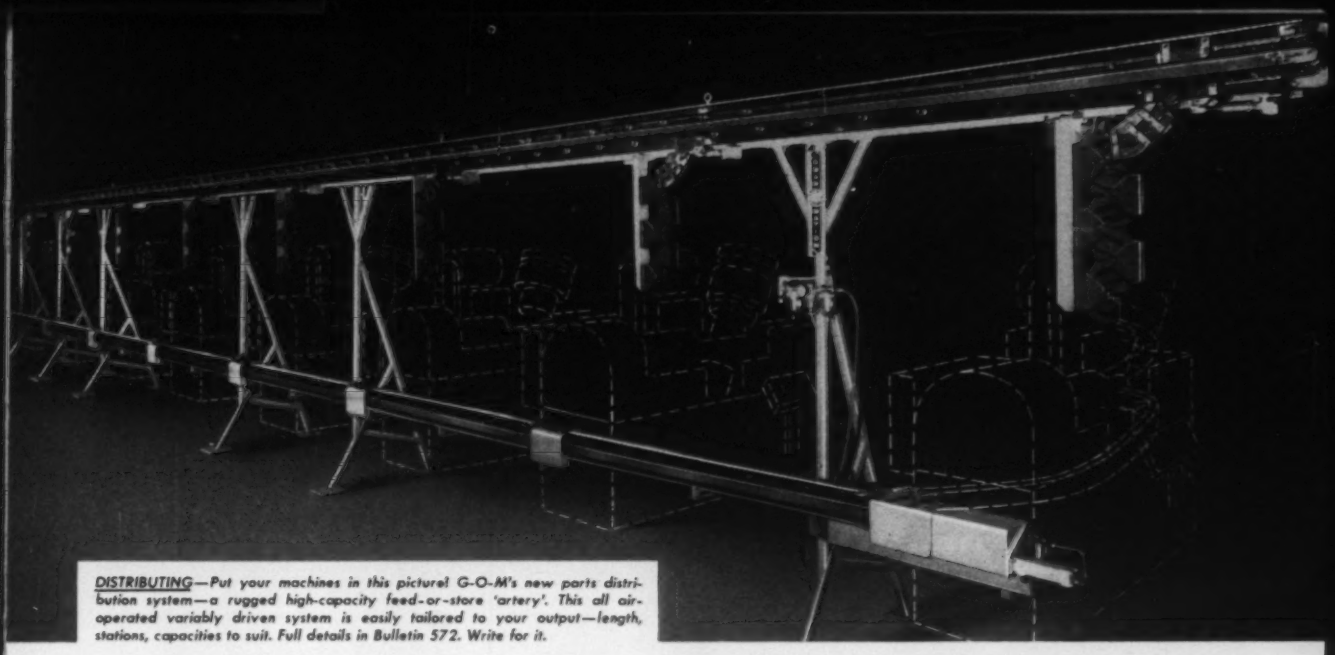


Fig. 4—Close-up of cylinder end of machine shows special line accumulator connected between check valve and control valve at blind and rods ends of cylinder respectively. Mechanical Air Controls, Inc. pneumatic valves for directional control of cylinder are grouped on sloping subpanel. Plan view of subpanel is shown above.



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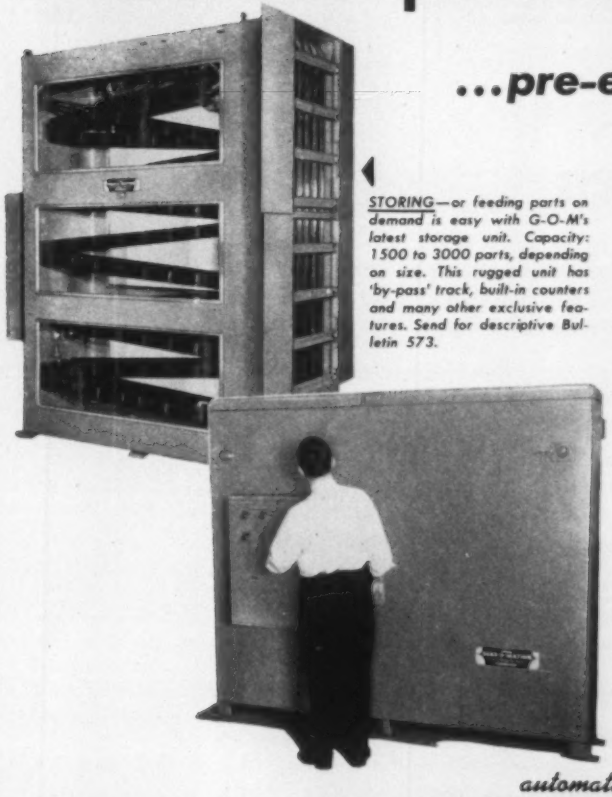

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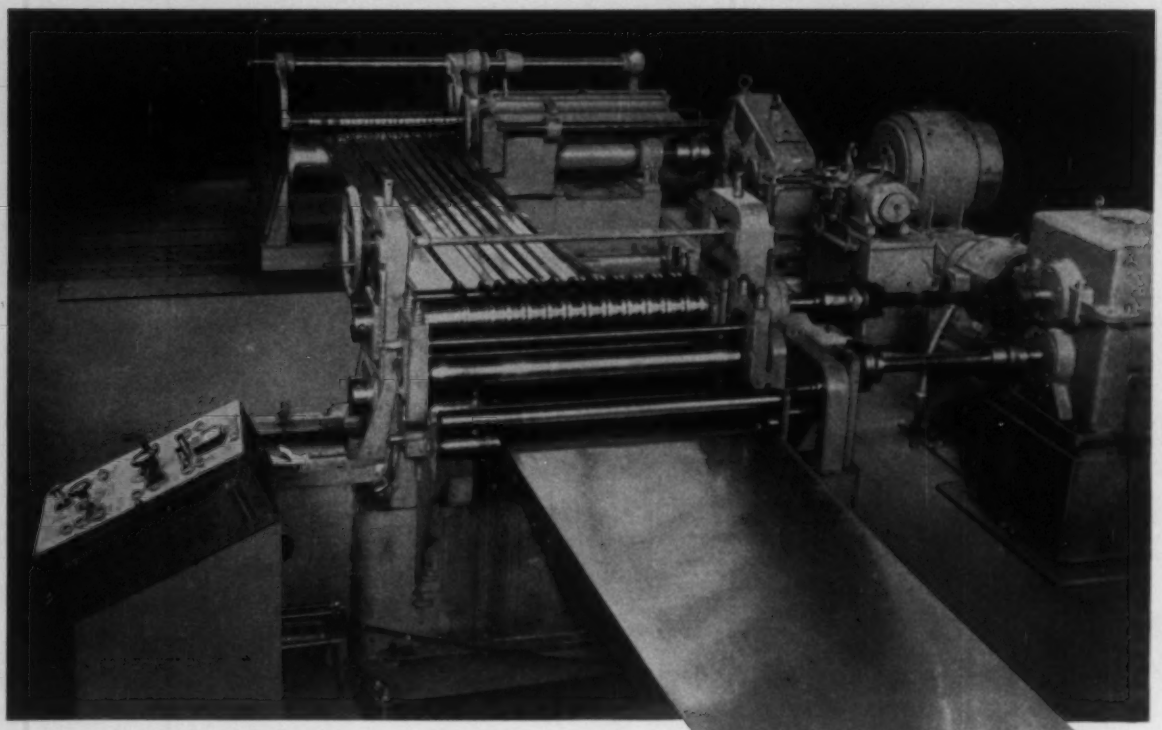

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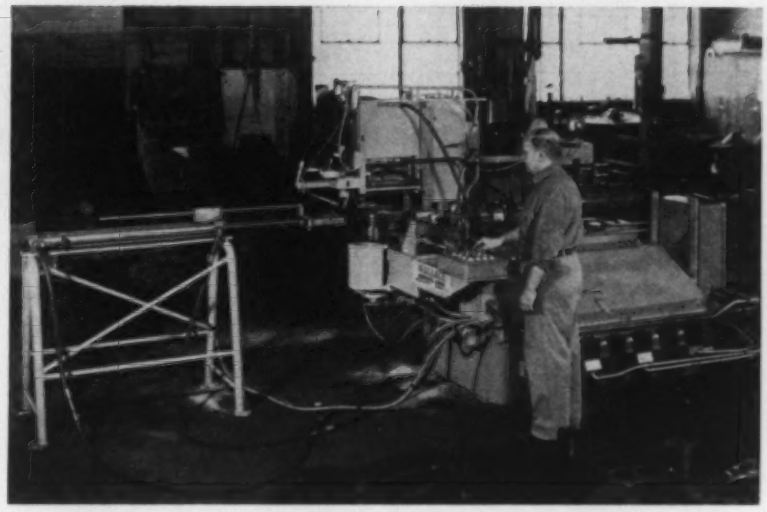
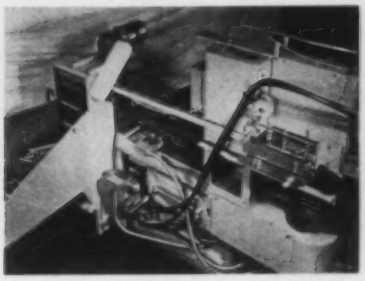
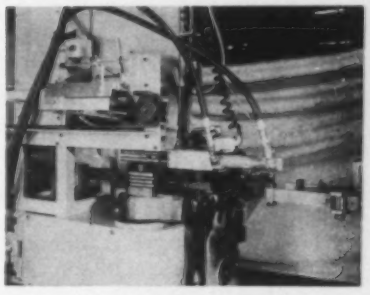


Over-all view of machine that bends copper tubes into L or U-shape automatically. Two tubes are processed during each machine cycle.



Vertical elevator containing fins at spaced intervals lifts tubes from a hopper and deposits them on a transfer belt. Transfer belt carries tubes in single file to a sorting mechanism that fills two stacked loading trays with tubes.



Two tubes, removed from forward ends of loading trays by a forked pin arrangement on a horizontal cylinder rod, are lowered into position between a clamping die and a forming die by action of a vertical cylinder. After clamping, tubes are bent and stripped from the machine by an unloading attachment.

Automatic Tube Bender Produces L and U-Bends

ORIGINALLY designed to permit salvaging of scrap lengths of copper tube by bending them into useful forms, automatic machine, built by **Wallace Supplies Mfg. Co.**, 1300 Diversey Parkway, Chicago 14, Ill., is adaptable to a variety of production tube bending jobs. L-bends can be produced at a rate of 1800 bends per hour and U-bends at a rate of 980 bends per hour. A simple tooling change permits selection of type of bend desired. In either setup, two tubes are processed during each operating cycle of the machine.

In automatic operation, a vertical elevator containing pickup fins at spaced intervals picks up tubes from a hopper and deposits them on a transfer belt. The transfer belt moves the tubes in single file to a position above a pair of vertically-stacked loading trays. Sorting fingers in this area route the tubes arriving at the loading trays in a manner to fill both trays with tubes. When approximately seven tubes are loaded in each tray, the vertical elevator is stopped automatically. It will not restart until the supply of tubes in the trays drops to two.

When a proper supply of tubes is available in the loading trays, a cylinder rod containing a pair of pins in a forklike arrangement at its ends is actuated. The pins are thus advanced horizontally toward the stacked loading trays and enter the leading tube in each tray. The hydraulic loading cylinder, pins, and tubes are next lowered by the action of a vertical cylinder so that the tubes are in position between a clamping die and a forming die.

The clamping die advances to secure the tubes to the forming die, the pins retract, and the loading cylinder is returned to its upper position. Mandrels are next automatically inserted in the ends of the clamped tubes to support the tubes during bending. The bending arm then swings to effect bending of the tubes. When this operation is completed the tubes are unclamped.

After the clamp opens, a stripper mechanism is actuated which removes the two tubes from the bend-

ing die and drops them onto a conveyor. Return of the bending arm to its original position completes one automatic cycle of the machine.

Unique features of the automatic bender include: Use of mandrels having internal channeling such that lubricant can be sprayed on the inside of the tubes as the mandrels are inserted; provision of an audible alarm that warns material handlers that 30 minutes or less remain before the tube hopper will be empty; and speed regulation of the hydraulically operated bending arm to provide optimum bending speeds for different types of bends.

Circle 401 on Page 141

Drilling, Assembling, and Staking Machine

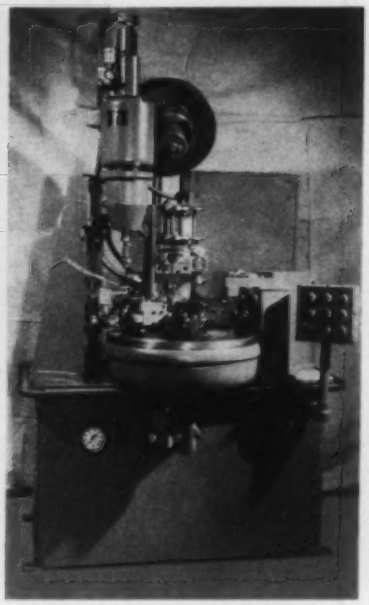
Item 402

Six-station semiautomatic machine employs a hydraulically operated rotary indexing table. Manual parts loading and unloading are performed at three of the stations. Equipment is designed to automatically drill a hole in the short leg of an L-shape part, insert a retainer pin in the drilled hole in an oriented fashion, and stake the retainer pin in place.

As the fixtures are indexed from the loading point to the first work station, a cam clamps the parts securely in the fixtures. They are held in this manner throughout their passage through the work stations.

At the first work station, a standard drilling unit is actuated automatically and a hole is drilled in the short leg of the L-shape part. Mist spray lubrication is applied to the drilling area and an air nozzle blows away chips.

Retainer pins are inserted in the holes at the second work station. A rotating hopper feeder orients the parts so that a plunger can insert them in the proper end-to-end alignment.

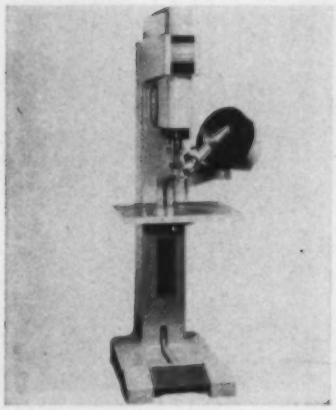


Staking of the retainer pin in place in the L-shape part is effected at the third work station. A compound linkage, actuated by a cylinder, exerts a maximum force of 6000 pounds for staking.

As the fixtures carrying staked assemblies are indexed from the third work station, an overhead cam releases the fixture clamps so the finished parts can be removed manually at an unloading station.

Electrical controls allow a choice of single or repetitive operating cycles, and single-cycling of the work stations for setup and maintenance purposes. A limit switch at the first work station will shut the machine down if the operator fails to remove a completed assembly and it indexes to this position. Improperly placed L-shape pieces will also actuate the limit switch and shut the machine down. **Vickers Machine & Tool Inc.**, Box 696, Columbus 16, Ohio.

Circle 402 on Page 141



Power Screwdriver

Item 403

Magazine-fed power screwdriver is available as a floor type machine or as a self-contained driving head for use in automatic assembly machines. Positive control clutch holds a constant torque, has no friction devices. It is adjustable from a minimum of 15 lb-in. to a maximum of 120 lb-in., holding a tolerance of ± 2 lb-in. at the lower end of the range and ± 6 lb-in. at the higher end of the range.

The barrel type feeder of Model U is driven from the main spindle drive motor through a flexible shaft and a gearless mechanism which needs no lubrication. The mechanism also acts as a safety device if there is a jam in the hopper. An air cylinder and a pressure regulating valve regulate the spindle stroke. The spindle can be stopped at any point and the up or down speed varied as required. **Detroit Power Screwdriver Co.**, 2805 W. Fort St., Detroit 16, Mich.

Circle 403 on Page 141

Analog/Digital Converter

Item 404

Unit is designed to convert unknown input voltages to four binary-coded decimal digits with an accuracy of ± 0.05 per cent of the converter input voltage $\pm$ the last significant digit. The output code requires 16 binary decisions—each decision is made in seven microseconds, and the 16 bits are determined in 112 microseconds.

In one application, Model B-617 is the central unit in a system used in the final production check-out of a weapons system. Other equip-

LEADERSHIP at work

Building machines for producing plastics—Operator John J. Urso mills a rotor for a plastics granulator with a Kearney & Trecker—Milwaukee Model CH No. 4 Ram Head mill. It's just one of a battery of 10 Kearney & Trecker mills specified by Fred Roddy, owner of Cumberland Engineering Co., Inc., Providence, R. I. Cumberland's experience underlines that of thousands of successful companies who know they can depend on the Model CH for the best in accuracy, work-range and power.

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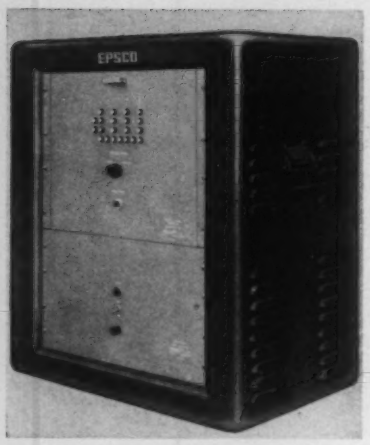
Hank Stewart, Stedfast & Roulston, Boston, continues to cooperatively re-appraise Cumberland's growing volume of machining work. *For expert milling counsel, call on the K&T man near you. And remember to ask him, or write direct, for free comprehensive catalog.*

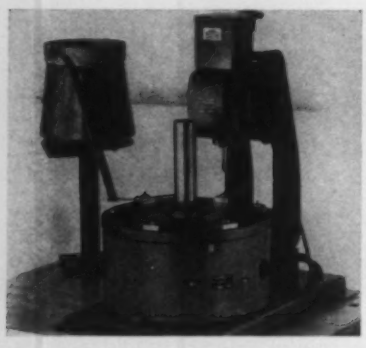
Kearney & Trecker staff photo by Ron Johnson

Circle 681 on Page 141



ment includes a magnetic core buffer storage unit, an output device, and an automatic typewriter or a paper tape punch. In operation, the unknown analog input voltage is applied along with an appropriate range selection signal. A process of successive approximations of the unknown input is initiated and continued until all the 16 decisions of the output code are determined. **Epsco Inc.**, 588 Commonwealth Ave., Boston 15, Mass.

Circle 404 on Page 141



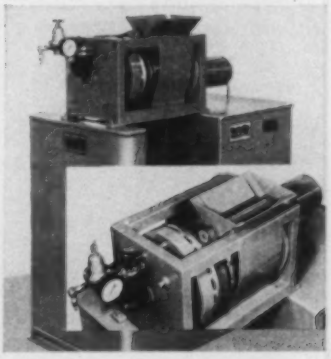
Automatic Staker

Item 405

Unit is designed for staking shading rings in solenoid armatures. It can also be adapted to other staking operations to speed the assembly of a variety of products. Machine consists of a solenoid operated punch, an indexing table, and a vibratory feeder. In operation, rings measuring 0.375-inch in diameter are automatically fed from a vibratory feeder down a track to an escapement and into nests. Armatures are hand fed to the nests. When both parts are in place, the table carries them under the punch. The punch is automatically actuated, staking the ring to the armature. After the staking operation, the assembled parts are automatically ejected by a small solenoid within the indexing table. Production rate is approximately 50 pieces per minute.

Impact force of the solenoid operated punch is controllable by means of a variable transformer. The speed of the feeder is controlled by a variable resistor. The indexing table is available in 6, 8, or 12 stations; is powered by a 1/20 hp gearhead motor and controlled by an electric timer. The staker is rated for 110 v ac, 60 cycle, single phase. **Black & Webster Inc.**, Newton, Mass.

Circle 405 on Page 141

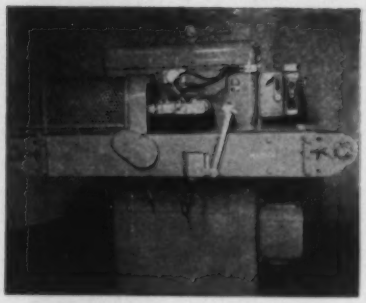


Air Leak Tester

Item 406

Automatic air tester can test approximately 2100 tubes an hour with positive rejection of tubes with leaks. It is applicable for testing a variety of cylindrical or tubular parts. In operation, a pulley-operated hopper feeds tubes into slots of a 16 station drum. When the drum carrying a tube revolves to a filling position, air under 50 psi pressure is applied to the tube. Satisfactory parts complete a 260-degree circuit and are ejected at the front of the machine. Leaking tubes are automatically ejected at the rear of the machine. The drum has a 12-inch diameter, is turned by a speed reducer, and revolves at a turning rate determined by the holding time specified for the test. **Steel City Testing Machines Inc.**, 8815 Lyndon, Detroit 38, Mich.

Circle 406 on Page 141

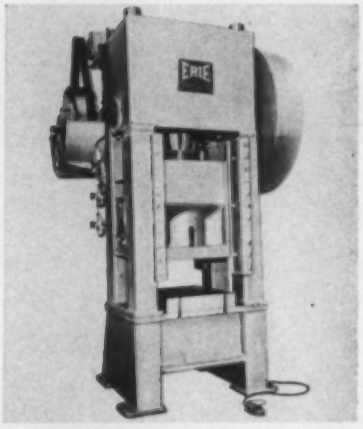


Cutting Unit

Item 407

Machine automatically cuts hot or cold, wet or dry material such as rubber, plastics, impregnated fabrics, reinforced hose, and natural and synthetic fibers. It can handle material up to 3 inches in diameter in lengths of 100 feet or more. Speeds of 1000 pieces per minute can be obtained. Standard equipment on Model 420-C includes a lubricating unit, conveyor tank, wetting tank, mist spray unit, and automatic speed control. **Wink Cutter Div., Motch & Merryweather Machinery Co.**, 1250 East 222nd St., Cleveland 17, Ohio.

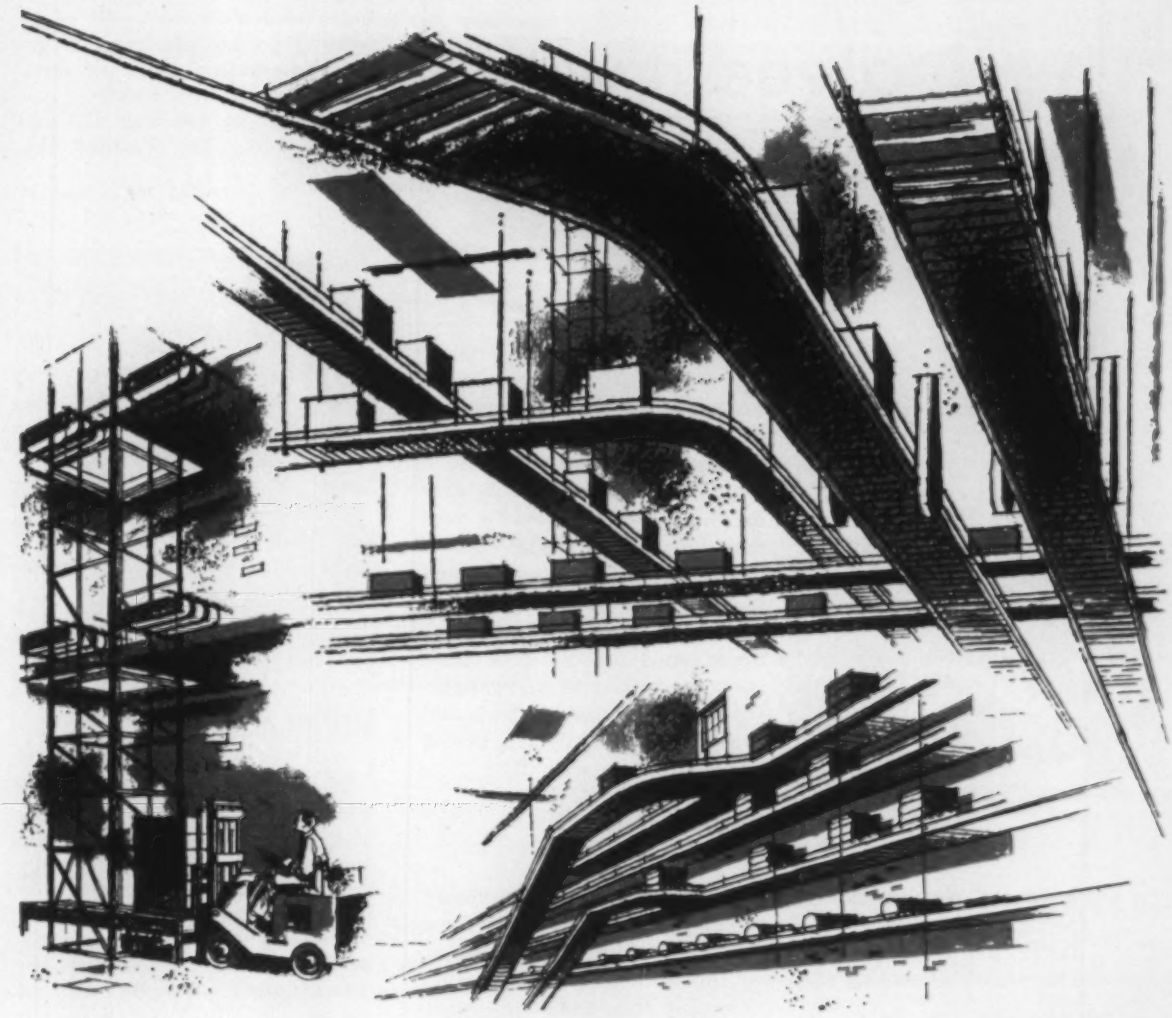
Circle 407 on Page 141



Trimming Press

Item 408

Press is designed for trimming forgings, can also be used for stamping, blanking, and drawing operations. Unit features central forced lubrication of all the bronze bearings and guides, air counterbalance, and power ram adjustment. Clutch is air operated, is engaged by compressed air and released by springs. The shoe brake is released by air and set by springs. The control is recess-mounted in the side hous-



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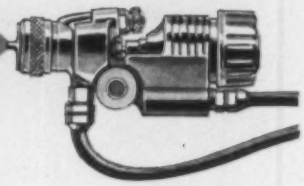
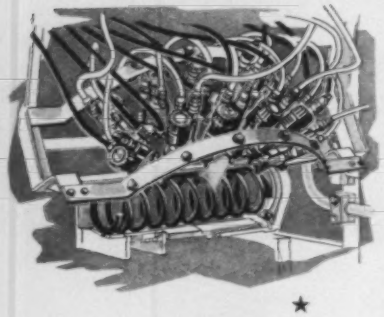
Circle 682 on Page 141

They solved it with...

AUTOMATIC SPRAY

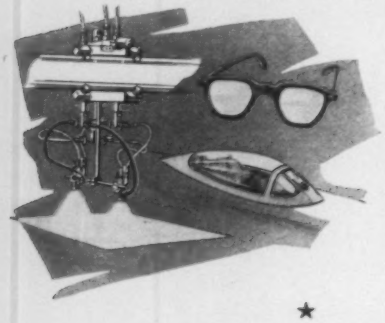


How do you test helical automobile springs to insure softer, smoother rides? An Ohio manufacturer found the answer in designing an Electronic Spring Tester equipped with twelve DeVilbiss automatic spray guns. Each spring fed into this machine is compressed to near maximum or to a predetermined measurement. The stress is transmitted to an electronic selector which actuates one of the automatic guns to color-code each spring according to its strength. Up to 900 springs can be tested in an hour—spray cycling taking less than half a second!



★ ★ ★

Increased demand and new uses for its plastic laminates prompted a leading New Jersey manufacturer to search for a faster, more efficient means to apply laminating adhesives. Uniformity of coating and constant production rates—highly critical in this operation—made precision spraying to close tolerances a must. A DeVilbiss automatic machine solved their problem. Holding a definite film thickness, it coats rows of 9″ x 18″ plastic sheets with adhesive at a speed of 16 feet per minute —or even faster if production warrants it.



★ ★ ★

If any of your operations involve the application of fluids, mastics, paints, or sprayable compounds, a DeVilbiss research engineer will gladly analyze your requirements without obligation, and help you determine if automation will pay off for you. Won't you call or write us? *The DeVilbiss Company, Toledo 1, Ohio; Barrie, Ontario; London, England. Branch offices in principal cities.*

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DEVILBISS

Circle 683 on Page 141

ing. Windows on both sides of the housing provide placement or removal of material from the press. Press is available in various speeds and strokes, in sizes from 150 tons to 600 tons. **Erie Foundry Co.**, Erie, Pa.

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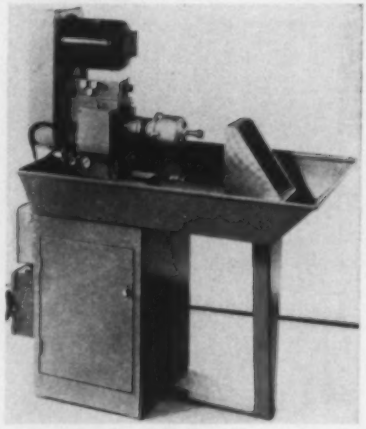


Driller & Tapper

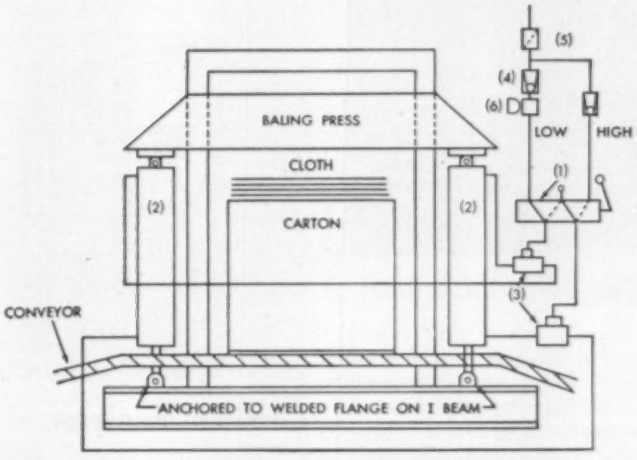
Item 409

Single-spindle horizontal drilling and tapping machine is capable of handling a large variety of second operation drilling, tapping, counterboring, burring, countersinking, facing, reaming, and hollow milling operations on screw machine parts, die castings, stampings, or headed parts. Capacity range of the machine is 0.020-inch to ⅜-inch drilling in mild steel and up to ⅜-inch tapping. Spindle speed range is between 500 and 10,000 rpm. Adjustable spindle feed through a 2½-inch maximum stroke length is obtained by means of intake and exhaust metering valves for a pair of pneumatic feed cylinders.

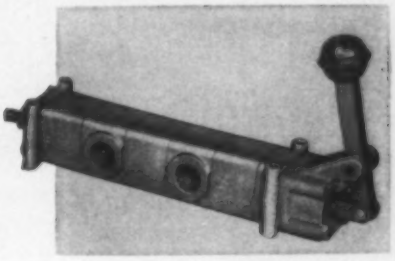
A hydraulic adjustment supplements pneumatic control of feeding on any 2-inch portion of spindle travel. A bottom dwell control furnishes additional control for fine surface finishing and holds repeatable depth limits within 0.0005-inch. An electrical circuit synchronizes spindle operation with clamping, positioning, indexing, or escapement mechanisms. Manual control is also provided for setup or test run. **Unimatic Machine Products Inc.**, 9545 Ainslie St., Schiller Park, Ill.

Circle 409 on Page 141

Westinghouse air circuitry cuts packaging labor costs 28%



Devices: (1) PD4-42-0001 PILOTAIR® Valve (2) "A" Cylinder (3) Quick Release Valve (4) Reducing Valve (5) Filter (6) Lubricator



"D" PILOTAIR® VALVE

The Westinghouse PD4-42-0001 PILOTAIR® Valve is the key to this entire pneumatic control system. "D" PILOTAIR® Valves are two-, three-, or four-way directional valves, with lever, cam, solenoid, pneumatic, pedal, and treadle operation. They have two and three positions, with port sizes of ¼" and ½" ips. They provide a choice of over 30,000 valve operator positions. Maximum operating pressure: 250 psi.

The diagram shows a baling press at the Arista Mills Company in Winston-Salem, North Carolina, makers of blue chambray cloth. The press was recently converted from heavy gear operation to pneumatic control. The pneumatic control system was designed by the Livingston & Haven Company, of Charleston, South Carolina. Westinghouse Air Circuitry has enabled Arista Mills to put 28% more cloth in each carton. Since labor costs per package are about the same as with their previous method, they are realizing an approximate 28% saving in labor costs. The heavier, more fully packed cartons also have cut handling costs, cut carton costs, and made available more critical warehouse space.

What is air circuitry?

Air Circuitry is the Westinghouse term for application of pneumatic control systems to industrial production operations. Safe, economical, precise Air Circuitry is now being used to solve the most rigorous and complex control problems in industry. Westinghouse Air Brake has pioneered the application and development of air control for more than 80 years. Today our engineers can design an air circuit which will help you boost production and cut costs in your plant or shop.

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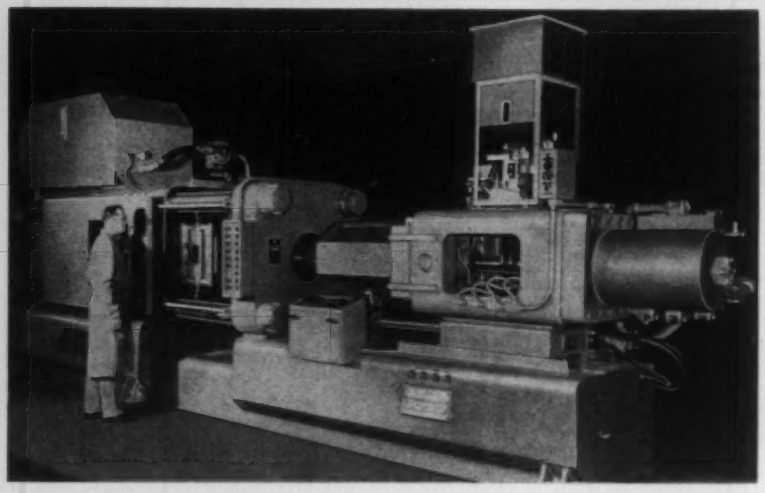


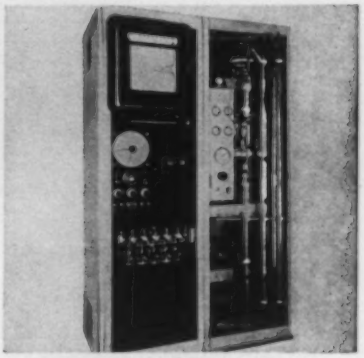
Plastics Injection Molding Machine

Item 410

Equipment features an injection rate of 2510 cu in. of material per minute, over 300 cycles per hour, and a hydraulic clamp with 30-inch stroke and 50-inch daylight. Adjustable limit switches provide variable stroke and daylight, slow closing action for die contact, and slow breakaway and injection stroke. The clamp and injection control circuits are separate to allow simultaneous traversing of both clamp and injection rams. The injection assembly is mounted on phenolic shoes in guided ways. Hydraulic pressure holds the nozzle against a sprue bushing and retracts the injection unit for purging.

The injection system of Model 650-HV-32/42 provides dual injection speeds, dual independent pressure settings, and automatic unloading of the high-volume pump. The plasticizing chamber is equipped with three heat zones, each pyrometer controlled. The heating bands are mounted directly on the spreader. **Hydraulic Press Mfg. Co., Div., Koehring Co.,** Mount Gilead, Ohio.

Circle 410 on Page 141



Chemical Analyzer

Item 411

Automatic recording analyzer is suitable for the ion exchange chromatography of amino acids and related compounds. Mixtures of amino acids including protein

hydrolysates, tissue extracts, or biological fluids can be separated and identified quantitatively. The analyzer meters buffers through one of a variety of ion exchange chromatographic columns supplied with the instrument. It then adds a precisely regulated flow of reagent to the stream. The resulting mixture flows into a heated reaction vessel through capillary tubing. Its passage requires enough time for optional reactions to occur, developing blue or yellow colors whenever amino acids are presented.

Photometer assembly includes three individual photometer units, each with a monochromatic light source, optical system, and photosensitive receiver. A precision flow type absorption cell traverses all three units to monitor the stream at wavelengths of 440 mu and 570 mu. The recorder prints three separate absorbance curves by means of multicolor dots. Calibrated flow meters permit observations of individual pump performances at any time during a run. **Phoenix Precision Instrument Co.**, 3803-05 N. Fifth St., Philadelphia 40, Pa.

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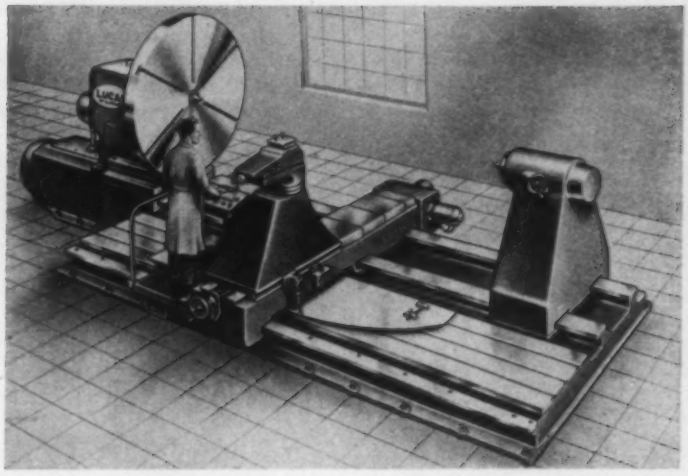

Tape Controlled Lathe

Item 412

Available in semiautomatic and tape-controlled automatic models, lathe is designed for turning operations on cylindrical, conical, or developed shapes. In the automatic type, the cross-slide and carriage are controlled by punched tape numerical positioning or magnetic tape-contouring control. Tracer control is used for the semiautomatic model shown in the photograph.

Speeds and feeds are infinitely variable and are controlled from a console mounted on an operator's platform which is attached to the lathe carriage. Constant cutting feed is maintained by a selsyn feedback system. This system, used with pick-off gears, provides a wide range of speeds and feeds for cutting threads. Units are available

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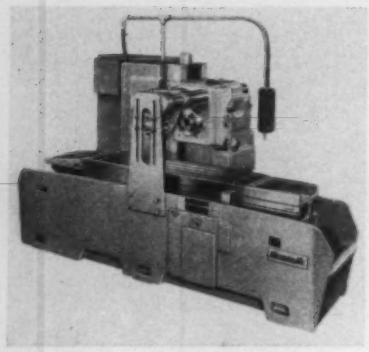
Circle 685 on Page 141

with up to 96 inches swing over bedways and up to 192 inches length. **Lucas Machine Div., New Britain Machine Co.**, 12302 Kirby Ave., Cleveland 8, Ohio.

Circle 412 on Page 141



Programmed Mill

Item 413

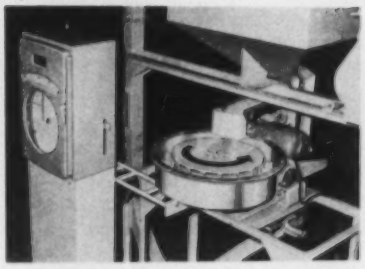
Unit features a control panel (not shown) on which each machine function to be controlled can be selected by means of dials. Under dial control, operations progress from one function to the next smoothly and quickly. A number of functions can be phased into a cycle, including automatic quill retraction, rise and fall of the head. and tracer control. Two-way milling cycles with automatic center stop for load and unload can be programmed. Pressing a button during center stop causes the cycle to resume. Stops can be made to occur at any place in the cycle. Line of bed type milling machines adaptable to panel control is available in 72 standard models, with power ranging from 7½ to 30 hp. **Kearney & Trecker Corp.**, 6784 W. National Ave., Milwaukee 14, Wis.

Circle 413 on Page 141

Continuous Weigher

Item 414

Designed for use with conveying or feeding equipment, device will weigh small lump, granular, or flaky dry bulk materials while they are in motion. Weigher can indicate material flow rates in pounds per minute, pounds per hour, or tons per hour. It can provide a chart record of flow rate for twenty-four hour periods and will record total

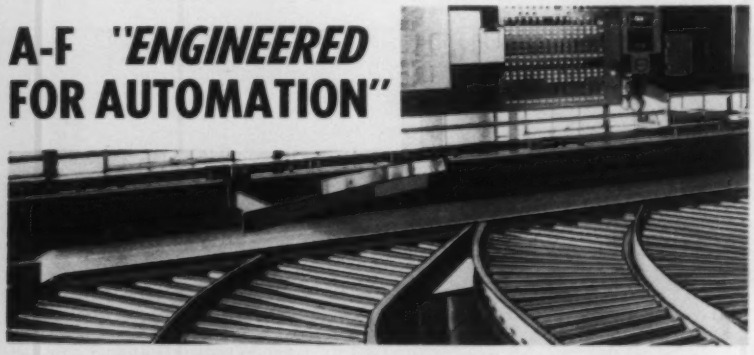


weight from starting time to any given moment.

In operation, the material enters and leaves the weigher at points which are in close proximity and are in line with the pivot axis of the weigher. A revolving turret, equipped with blades, moves the material through a circular trough from intake to an adjacent outlet point. Pressure is exerted on a mechanical linkage in proportion to the material volume being fed. The recording is made through an indicator head actuated by the linkage. **Stephens-Adamson Mfg. Co.**, Aurora, Ill.

Circle 414 on Page 141

A-F *"ENGINEERED FOR AUTOMATION"*



Produces Money-Saving Conveying Systems

No automated sequence of operations can be more efficient than the conveying system which links and integrates them.

But—because A-F pioneered automated conveying systems . . . and has furnished automated conveying systems to plants throughout the world . . . you can be *sure* of superior performance from an A-F *Engineered* Conveying System!

An A-F *Engineered* completely co-ordinated Conveying System can effect substantial economies in your plant. What better time than *now* to write us—without obligation, of course.

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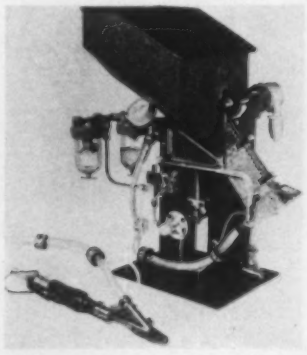
THE ALVEY-FERGUSON CO., 174 Disney St., CINCINNATI 9, OHIO and Azusa, California



Automatic Fastener

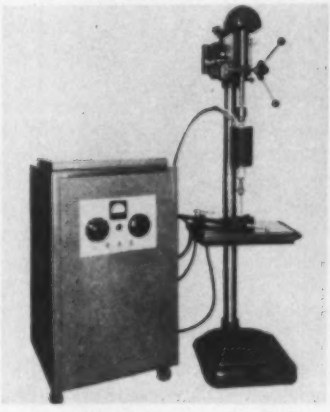
Item 415

Adaptable to all types of power screwdrivers, as well as portable use, automatic fastener is controlled by a pneumatic device which permits only one screw at a time to be fed from the supply hopper to the driving head. When a previous screw has been driven, the next is blown through a transparent plastic tube to a three-jawed screw holder where it is gripped as in a drill chuck. The holder retains tthe screw in driving position, regardless of the driving angle, so that the screw acts as a finder or drift. The driver head can be used at any angle to drive all types of screws, includ-

Circle 686 on Page 141

ing those with preassembled washers. **Parker-Kalon Div., General American Transportation Corp.**, Clifton, N. J.

Circle 415 on Page 141



Electric Disintegrator

Item 416

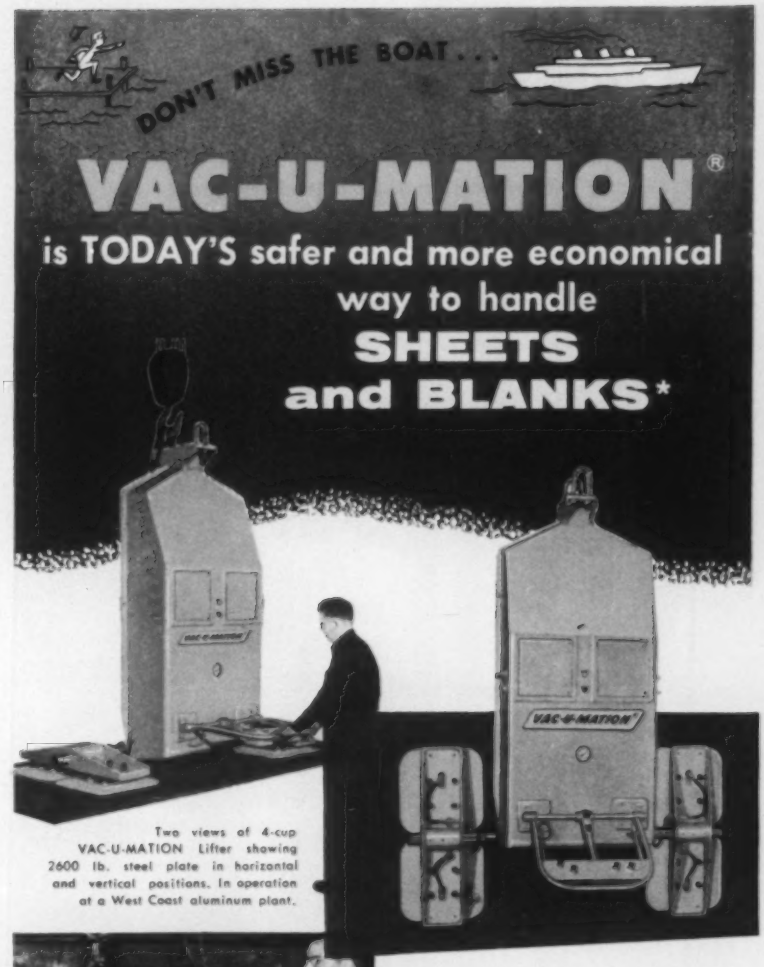
Designed for use with machines such as drill presses, electric arc metal disintegrator provides an accurate means of drilling curved and other shaped holes in hard metals such as hardened steels, carbide, titanium, and cast alloys. It can also cut slots, oil holes, pilot holes, and end mills, or remove broken taps, reamers, studs, setscrews, ejector pins, and bushings. The cutting action of Model C-66, which has its own coolant pumping system, is accomplished by creating a series of intermittent electric arcs which disintegrate metals. The cutter tool is an electrode which is held in the disintegrating head. A coolant is pumped through the electrode to wash away the particles of metal as they are removed. **Cammann Mfg. Co. Inc.**, 2700 Henninger Rd., Cleveland 9, Ohio.

Circle 416 on Page 141

Powder Filling Machine

Item 417

Designed for volumetric filling, powder filling machine is adjustable for quantities from 25 mg to 8 grams, with speeds up to 32 fills per minute. Unit is practical for sticky and hygroscopic powders. Setup consists of the setting of agitation and feed to effect a controlled number of revolutions of an auger, and thus deliver the required



Two views of 4-cup VAC-U-MATION Lifter showing 2600 lb. steel plate in horizontal and vertical positions. In operation at a West Coast aluminum plant.

2-cup VAC-U-MATION Lifter at CATERPILLAR TRACTOR, Joliet, Illinois plant handling 500 lb. sheets on squaring press.

VAC-U-MATION shortens man-hours—cuts handling costs—pays for itself F-A-S-T. For example, a big electrical manufacturer says VAC-U-MATION has cut a three-man hazardous chore of unstacking and cutting metal sheets weighing up to 400 lbs. each to a safe, efficient one-man operation.

VAC-U-MATION is growing up. Why not look into it for your sheet and blank handling?

*STEEL, ALUMINUM, GLASS, WOOD, etc.

4581C

14" diameter waffle-faced cup with neoprene rubber.

Molded on steel backing plate equipped with 4 mounting holes. Other designs for 6", 8" and 10" diameters available.

20" square waffle-faced cup with neoprene rubber.

Molded on aluminum backing plate equipped with 4 mounting holes.

Rectangular cups with neoprene rubber molded on steel backing plate. Sizes 2½" x 8¾6" and 3½" x 16".

R. J. LITTELL MACHINE CO.

VAC-U-MATION DIVISION
4105 Ravenswood Avenue, Chicago 13, Illinois
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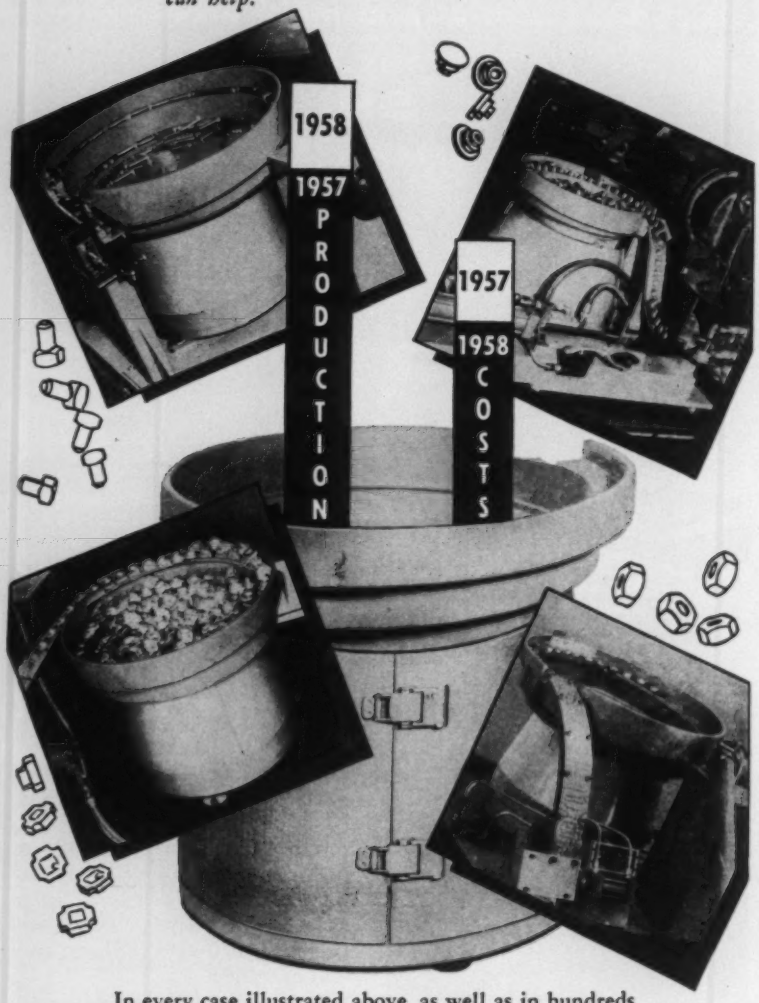
Write for NEW Catalog!

Circle 687 on Page 141

the shortest route to MORE PROFIT
. . . produce MORE in 1958!

If you can reduce costs while producing more, the job is twice as easy. This is where PEECO can help.



In every case illustrated above, as well as in hundreds of other examples, PEECO successfully helps production men reduce their costs by producing more—automatically.

If your equipment, machinery, production or assembly line is *not* now using parts feeders the chances are your costs are too high. Let a PEECO Sales Engineer give you the facts. He'll gladly help you without obligation. Write for literature and name of representative near you.

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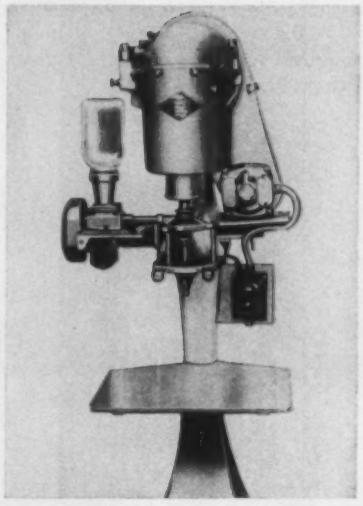

amount of powder from the filling hopper into the container. A positive feed is provided, and a variable flow provision insures constant material level in the filling hopper. Close synchronization and tolerances of agitator blades and auger prevent bridging, fluffing, or material buildup on the auger or in the hopper. All parts which come in contact with powders can be removed for sterilization. **Arenco Machine Co. Inc.**, 25 W. 43rd St., New York, N. Y.

Circle 417 on Page 141

Dispersion Mill

Item 418

Equipment is suitable in the food processing, product coating, pharmaceutical, chemical, and cosmetic industries. It provides a method for wet milling and grinding, homogenizing, dispersing, emulsifying, and extracting. The mill serves as its

Circle 688 on Page 141

own pump, drawing material down through a multistage grinding area to preset sizes and then ejecting the product under pressure. It can be operated on a continuous throughput basis, so it can be tied into continuously operating production lines; or it can be used for batch operations.

Mill consists of a conical ring-shaped grooved stator with from two to five grinding stages. Within the stator, a grooved rotor turns at high speed. The rotor and stator are arranged in a manner to form a milling gap or slit between the two parts. Width of the gap decreases in a downward direction. The gap can be regulated for various settings by a calibrated adjustment device. Crushing, grinding, and homogenizing are performed by mechanically produced vibrations of high frequency within the grooved milling stages. **Pfaudler Co.**, 1062 West Ave., Rochester, N. Y.

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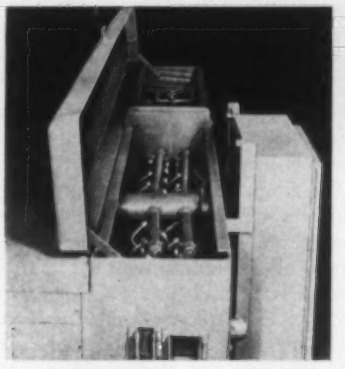

Automatic Parts Washer

Item 419

Designed for all types of parts that roll, washer can be installed horizontally in-line with an overhead parts distribution system. Automatic washer feeds parts through a spray-wash and an air-jet drying stage at the rate of 950 parts per hour. In operation, parts are fed onto retaining tracks and are driven through the washing and drying sections by dogs on a chain drive conveyor. Most of the time the parts roll freely through the unit, out of contact with the conveyor dogs. The parts are spray washed from nozzles at 40 psi. Then they pass through a blow-off unit where multiple high-pressure air jets

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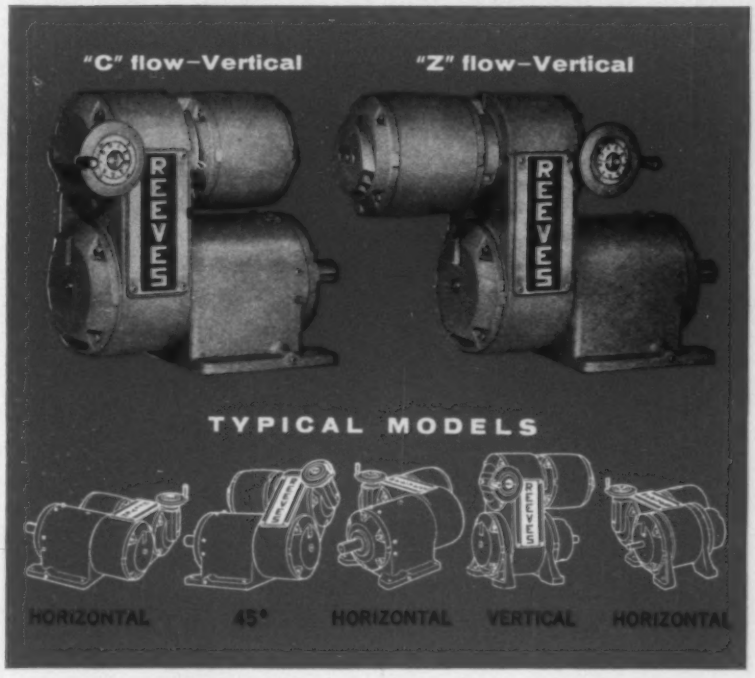
*Sizes 200-300-400 Vari-Speed MOTODRIVES**

* *200-300-400 Sizes, 1 through 10 hp.; full line, ¼ through 40 hp.*



The flexible design of these compact new REEVES variable speed power packages permits hundreds of combinations . . . space-saving, space-fitting *standard* assemblies to meet most installation requirements. All models are available in both "C" flow and "Z" flow styles.

New increased capacity is built in the reducers—single, double or triple stages . . . new disc assemblies permit wider output speed ranges . . . discs are pre-aligned . . . pre-loaded spring maintains correct belt tension for longer belt wear . . . *exclusive* "close-grooving" lubrication assures free sliding discs . . . new Metermatic system automatically lubricates the motor and variable shaft bearings.

Complete information on all phases of the versatile 200-300-400 sizes Vari-Speed Motodrives is given in new Catalog. Write for your free copy today—Dept. AN 32a-M571.

REEVES PULLEY COMPANY

Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

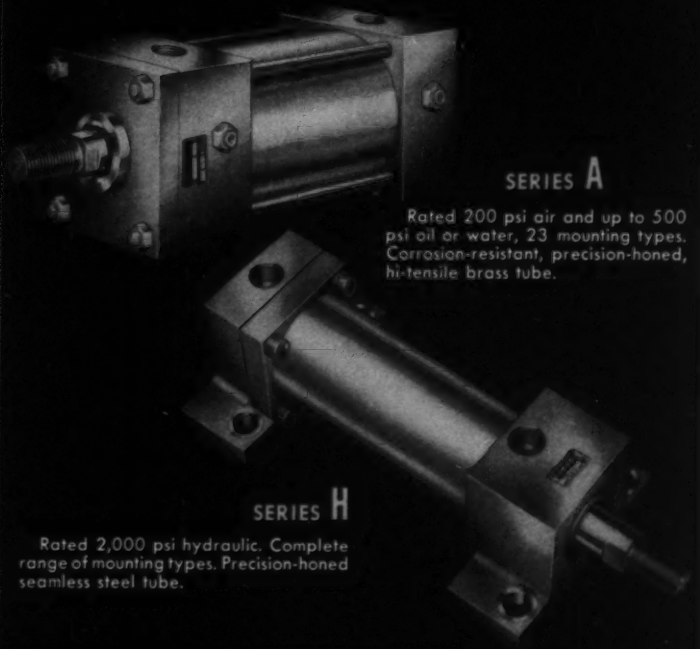
Columbus, Indiana

Circle 689 on Page 141

for increased production . . .
minimum down-time . . .
lower costs . . . specify

SP

AIR and HYDRAULIC CYLINDERS



SERIES A

Rated 200 psi air and up to 500 psi oil or water, 23 mounting types. Corrosion-resistant, precision-honed, hi-tensile brass tube.

SERIES H

Rated 2,000 psi hydraulic. Complete range of mounting types. Precision-honed seamless steel tube.

- floating cushions—uniform cushioning—long life—fully adjustable
- easily removed cartridge-type rod seals with integral rod wiper
- choice of rod sizes for all applications—rods heat-treated and hard chrome plated for resistance to nicking and scoring
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- all ferrous parts rust-proofed

Before you buy any cylinder, consider the quality design and construction features of S-P air and hydraulic cylinders—features that will assure dependable performance . . . long service life . . . minimum down-time . . . lowest end cost.

What's your cylinder problem? We'd like to help you solve it—a phone call will bring our representative on the double. Prompt deliveries, too. The S-P Manufacturing Corporation, 30201 Aurora Road, Solon, Ohio.

SP for speed and performance

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AA-7487

clean and dry each part. The parts continue to a roll-off point for direct re-entry to the main distribution system. Unit is available in any height up to 10 feet. **Gear-O-Mation Div., Michigan Tool Co.**, 7173 E. McNichols Rd., Detroit 12, Mich.

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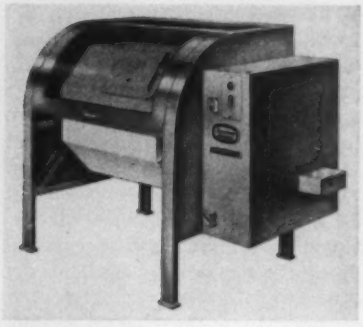

Barrel Finisher

Item 420

Barrel finishing unit is capable of finishing small parts as well as large castings and forgings. Total barrel capacity is 13.8 cu ft or 1000 lb. Barrel can be divided into two compartments. Features of the unit are a roll-away perforated hood, a cam-operated door, and self-aligning bearings and expanding dirt-seal rings. Barrel is driven by a 1½ hp motor through a helical-gear speed reducer; a variable speed control allows adjustment of barrel rotational speed from 10 to 30 rpm. Model EB-3032 is available unlined or with a Neoprene lining. The lining cushions parts and allows the use of corrosive and other materials. Optional equipment includes a drain door to permit fast drainage of water from the workload, an unloading boot, and single and dual timer controls to provide automatic delayed starting and automatic stopping for accurately controlled running cycles. **Almco, Queen Products Inc.**, Albert Lea, Minn.

Circle 420 on Page 141

Magnetic Testing Unit

Item 421

Instrument is adaptable for the production testing of ferrous parts up to 24 inches long. Suspended magnetizing coil and heads permit

compare two files of punched cards simultaneously in order that the cards can be matched, merged, selected, and checked for subsequent accounting operations. In operation, cards are entered into the machine from card feeding devices at each end.

The main feed consists of a file feed device that can hold up to 3600 cards; the secondary feed is a conventional card hopper. Cards enter from each feed device at the rate of 650 per minute. When both feeds are in use, up to 1300 cards per minute can be processed. Features of Model 88 include error detection circuits which guard against double punches and blank columns on the card record, and sequence-checking units which allow the unit to perform identical or completely different operations in each feed at the same time. **Data Processing Div., International Business Machines Corp.**, 112 E. Post Rd., White Plains, N. Y.

Circle 422 on Page 141

conveying parts either through or across the unit. Inspection is performed by placing the part between the heads for longitudinal magnetization or in the coil for circular magnetization. As the magnetizing current is maintained, the part is flooded with a solution containing fine magnetic particles which may be fluorescent. The particles accumulate along any flaws, marking all defective areas. Black light shows fluorescent particles as glowing indications. The coil, which pivots and slides along the overhead track, can be moved to the right for circular magnetization, placed between the heads and used with them, or stored to the left when not in use. Model NQ-242 operates from 220/440 v, 50/60 cycles, 3 phase current; dc magnetizing output is 1750 amp through the heads and 600 ampere-turns through the coil. **Magnaflux Corp.**, 7300 W. Lawrence Ave., Chicago 31, Ill.

Circle 421 on Page 141

Card Filing Unit

Item 422

Function of card filing machine is to arrange punched cards in any desired sequence. Collator can

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the technical know-how to "*engineer*" more speed and profit into your assembling operations.

● The signal success of DPS trained engineers in adapting power equipment to the individual feeding and assembling needs of industrial plants everywhere is assurance that they can likewise solve your special problems. In our broad line of

SELECTIVE PARTS FEEDERS
POWER SCREWDRIVERS
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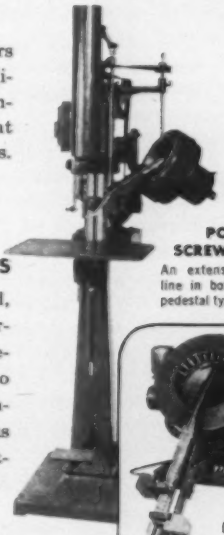
BOWL FEEDER
Electrical vibratory type to feed parts that cannot be tumbled.

equipment can be selected, and custom features incorporated, to fit your requirements. Plan now to use DPS modern assembling methods. Tell us your set-up. Write for catalog and further details.



POWER SCREWDRIVERS
An extensive, versatile line in both bench and pedestal types.

BARREL FEEDER
Popular motorized type, for parts requiring critical selection.

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Circle 691 on Page 141

Man's Eternal Struggle with the Machine

AS PROFITS SHRINK AND COSTS CONTINUE TO GO UP, MORE THAN JUST "THE VENDOR'S QUOTATION" IS NEEDED!

Certainly you have to depend on your vendors... but how much?

The answer is "completely"! Your job is tough enough without your having to be a machine design or materials handling expert, too.

When you're specifying equipment, you should *only* have to provide an objective explanation of the problem, as well as the understanding of the product and related processes.

The vendor is the expert who's supposed to analyze that problem, then design and supply the necessary equipment. And the equipment should be ready to do your job when it's installed, too. Your overhead can't afford the lost production time and expense while you test and prove the vendor's equipment for him. After all, your original specifications called for equipment *to do a particular job.*

Sciaky has always accepted the vendor's full responsibility for design, manufacture and *delivery into production* according to the original specifications. That's why Sciaky resistance welding and production equipment satisfies the requirements of *your* particular job. That's why Sciaky operates the only independent, fully staffed and equipped Research Center devoted to advancing the application of resistance welding processes.

Why take less than the full advantage of consulting with a Sciaky Application Engineer the next time you are considering equipment. No obligation, of course.

The manufacturers of automobile wheels took that advantage. As a result those wheels are now assembled with automatic resistance welding that includes four other operations—not only assembled better, but faster and at lower cost. Write for the details of this unusual high production application that satisfies the most rigid specifications for weld quality.

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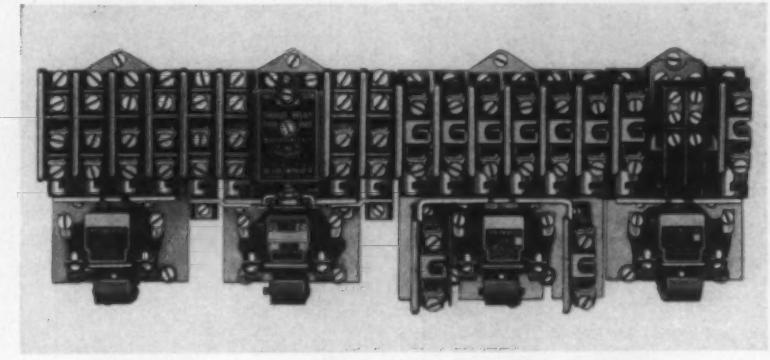
AUTOMATION new components

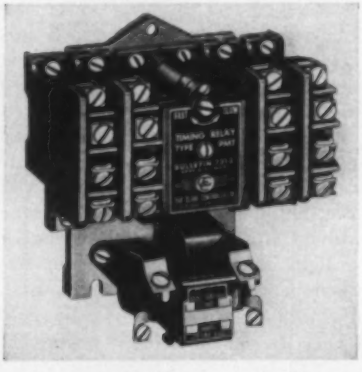
Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card on page 141.



Timing Relay for Uniform-Height Line

NEW pneumatic time delay relay completes a line of 10-amp units which have uniform vertical height and mounting dimensions, permitting various styles from the line to be intermixed in uniform rows on control panels Unit, designated Type PMT, was developed by **Clark Controller Co.**, 1146 E. 152nd St., Cleveland 10, Ohio. Relay has universal poles with isolated contacts so that two circuits per pole can be used, even at opposite polarity. This feature permits the two sets of contacts on each pole to be used for separate circuits, without the possibility of sneak circuits. Unit is accessible from the front for wiring, inspection, and maintenance. The poles are mounted in independent melamine pole blocks, can be individually removed and replaced without disturbing other poles or wiring.



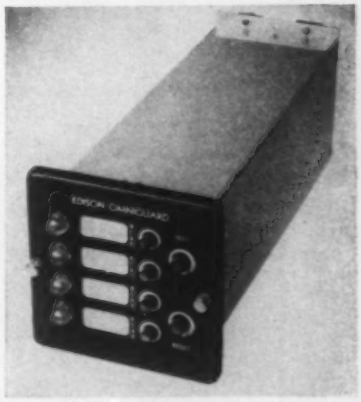
Type PMT has 32 variations of five basic models. Four Class A models have a time delay adjustable from 0.2 sec. to 3 min., with repetitive accuracy of ±10 per cent. The Class B model is adjustable from 0.2 sec. to 1 min., with repetitive accuracy of ±16 per cent. The units offer a range of from zero to three instantaneous poles with one or two timed poles, each pole providing one normally-open and one normally-closed contact. All models are available for *On-delay* (time delay following energization) or *Off-delay* (time delay following de-energization). Conversion between *On-delay* and *Off-delay* can be made in the field, and poles are interchangeable between timed and instantaneous operation in the field.

Circle 423 on Page 141

Temperature Monitor

Item 424

Using independent circuits, system is capable of providing continuous monitoring of large groups of temperatures. The continuous monitoring results in a fast response and rapid activation of the alarm circuit. The use of independent circuits decreases the possibility of an entire system failing at one time. System includes a group of Wheatstone bridge circuits. Resistance temperature detectors form one leg of each bridge. A current-sensitive relay across each bridge operates when the bridge becomes unbalanced due to a high or low detector resistance. An auxiliary relay, operated by the sensitive relays, operates an alarm light on the face of



the panel and energizes external alarm devices which are connected to the monitor unit. Momentary switches on the face of the monitor unit permit reading any temperature at any time. A switch tests the operation of each monitor unit and a reset switch returns the instrument to normal after the test

or when an alarm condition has been experienced.

The monitor unit is an annunciator which identifies each point monitored and locates alarm points by means of a red alarm light adjacent to each identification strip. Each alarm point can be individually adjusted from the front of the monitor without removing the instrument from its mount. A standard monitor unit consists of four bridge circuits which monitor four temperatures. For large installations, one or more plug-in monitor units can be grouped together with a single indicator.

For assured reliability, resistance temperature detectors can be used as temperature sensing elements. Company's miniature detectors are less than 1/4 inch in diameter by 3/8 inch long; have a basic resistance of 120 ohms; are available for temperatures ranging from −150 F to +1350 F. **Instrument Div., Thomas A. Edison Industries,** West Orange, N. J.

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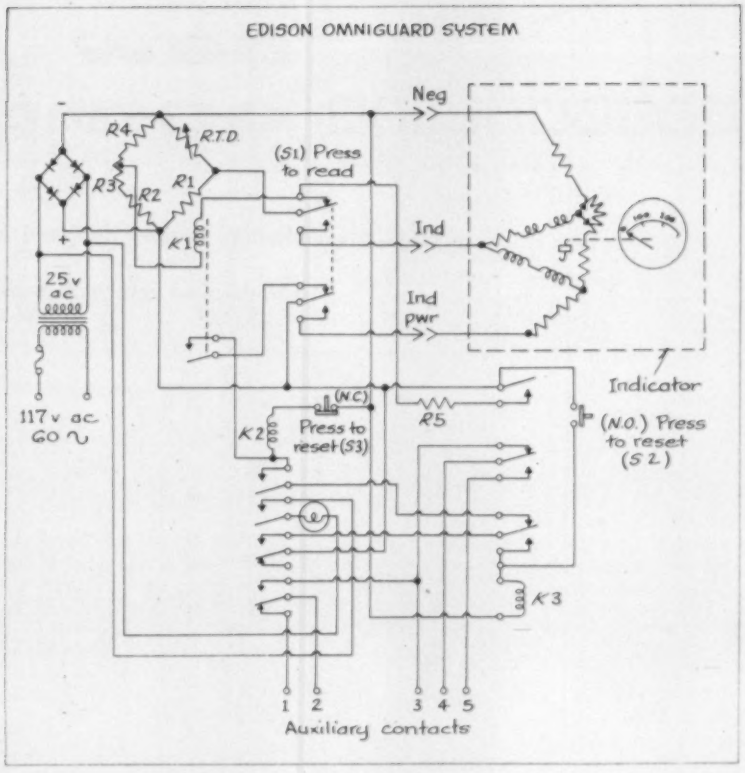

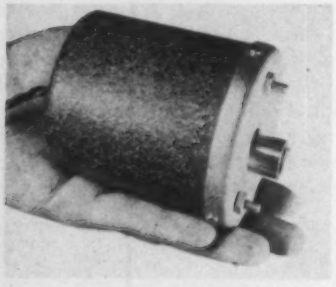

Item 425

Control Gear Motor

Device has a hollow output shaft, is available with or without a built-in potentiometer to provide remote or automatic control of valves, variable speed drives, variable displacement pumps, positioning screws, and arc welders. The motor can be mounted directly on the driven shaft to replace handwheels, cranks, or levers. Model SM-5 has a gear reduction of from two to four stages with ratios from 80:1 to 1600:1, provides a continuous duty torque rating of 75 lb-in. A separate gear train drives the potentiometer so that full scale potentiometer movement is obtained with from 90 to 450 degrees on the output shaft. When used with company's 5.5 amplifier, the motor provides positioning control in adjustable proportion to a 0.5 to 5 ma signal, a 3 to 15 psi air signal, or the output from any electrical transducer. Unit is rated for 110 v, single phase. Larger models are available, will deliver torques to 800 lb-in. **Jordan Co. Inc.,** 3235 W. Hampton Ave., Milwaukee, Wis.

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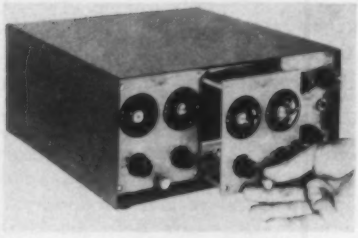

Electronic Counter

Item 426

Preset instrument is applicable for control functions such as counting, sorting, batching, winding, and packaging. Model 320 can accept any standard waveform, will count at a maximum rate of 5000 counts per second. Counter includes one pluggable amplifier and control unit and a combination of pluggable 2 or 3-decade modules. It is furnished with from 2 to 6 digits.

Coupled inputs (ac or dc) are selected from the front panel. The total is preset and when it is reached, the counter provides an output pulse. A wide range of control functions are provided. In the *Pulse Only* position, the counter delivers a large pulse of voltage to the output load at the end of each preset counting interval then automatically resets itself and resumes counting. When the switch is set in the *Relay* position, a control relay closes when the desired count is reached. The duration of the relay closure, variable up to 5 seconds, is determined by a *Hold Time* control on the panel. In the *Relay Latch* position, when the desired count is reached, the control relay closes and the count is held indefinitely. Available accessories are: an ac amplifier to increase sensitivity from 1 v to 25 mv, and a 5-digit batching register. **Erie Resistor Corp.,** 644 W. 12th St., Erie, Pa.

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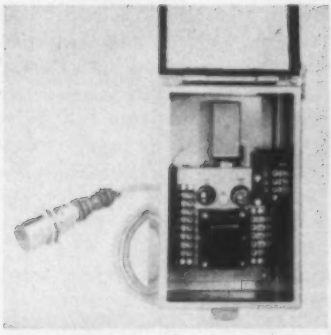

Proximity Limit Switch

Item 427

Switch is a sensing device for the detection of magnetic materials. It can be used as a proximity control, limit switch on automatic machine tools, sensing switch for high speed parts counter, alarm signal, or bearing wear detector. Unit detects the magnetic materials without the use of light beams, mechanical linkage, or physical contact. A differential transformer transducer is used as the sensing device. When a ferromagnetic object passes within range of the sensor head, a signal is generated, actuating the control relay. The switch is capable of detecting magnetic materials through an air gap up to one inch. The sensing coil is adaptable in ambient temperatures of −40 to 250 F. Relay is rated at 115 v, 60 cycles, contact rating is 3 amps at 115 v, 60 cycle noninductive. **Automatic Timing & Controls Inc.**, Dept. 201, King of Prussia, Pa.

Circle 427 on Page 141

Circulating Pump

Item 428

Circulating unit is capable of handling water and nonabrasive fluids in various industrial applications. Pump has 1-inch threaded intake and discharge connections, handles line pressures up to 150 psi, and fluid temperatures up to 230 F. Motor and pump are enclosed in one sealed unit, need no starting device. The pump can be installed in any position; is replaced or serviced with a screwdriver. **Pump Div., Fostoria Pressed Steel Corp.**, Fostoria, Ohio.

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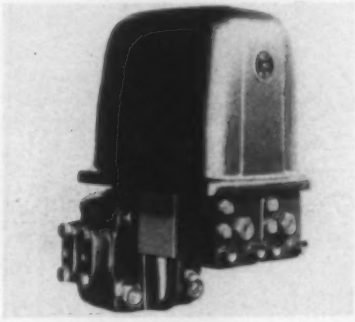

Flow Transmitter

Item 429

Instrument pneumatically transmits rate of flow measurements to indicating, recording, integrating, or controlling equipment at remote stations. It is suitable for steam, water, air, gases and other fluids which can produce differentials across primary elements from 0-2 inches water to 0-2000 inches water at maximum service pressures of 50, 1500, and 5000 psig. Stability is maintained by a reset type booster relay. Transmitter has a built-in square root extractor, can accept a pneumatic signal which varies linearly with the rate of flow. Its linear rate-of-flow signal can easily combine with pneumatic signals from other linear transmitters. Unit can be mounted on process piping, on the wall, or on a separate mounting pipe. **Bailey Meter Co.**, 1050 Ivanhoe Rd., Cleveland 10, Ohio.

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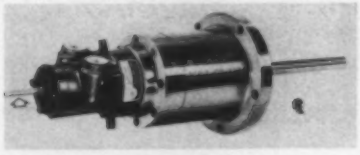

Rotating Cylinders

Item 430

Line of rotating cylinders with integral actuator/indicator rod extensions is suitable for use on automatic boring heads, automatic lathes, screw machines, and reels. The indicator rod extension is designed to actuate limit switches in conjunction with cylinder operation or to indicate piston position.

Rod extension is offered on company's Model RC rotating hydraulic cylinders, which are available in bore sizes of 3, 4½, 6, and 8 inches, with 1, 1½ or 2-inch strokes. The rod is piloted and pinned to the piston assembly and protrudes through the inlet housing end cap. Rod is ¼ inch in diameter, furnished with a plain or threaded end. Rod travel and piston travel are identical and rod lengths are made for individual requirements. **S-P Mfg. Corp.**, 30201 Aurora Rd., Solon, Ohio.

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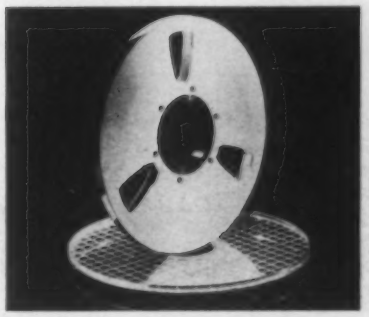
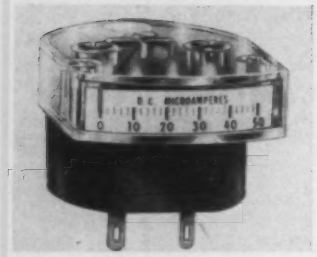


Magnetic Tape Reel

Item 431

Device is applicable on machine control systems and electronic computers, can be used on all conventional instrumentation tape recorders. The tape-threading slot has a high-friction synthetic rubber ring bonded to the hub which enables the tape to grip the reel with a single turn by hand to bury the end of the tape. The self-centering hub has a machined, built-in shoulder for proper centering of the flanges, and each flange is anchored with six screws. To protect the tape edges, the flanges are designed as a solid disc with three slot-like openings for threading and a visual check of the tape. Reel is available in 10½ and 14-inch diameters for use with ¼, ½, ¾, and 1-inch instrumentation tape. **Minnesota Mining & Mfg. Co.**, 900 Bush St., St. Paul 6, Minn.

Circle 431 on Page 141

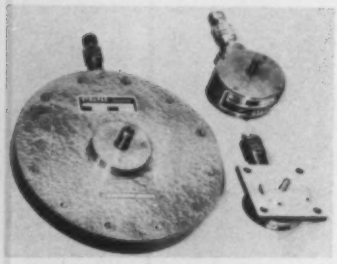


Panel Meter

Item 432

Miniature edgewise panel meter is designed for use in compact areas. Unit is also suitable in places where weight is a factor (Model 120 weighs four ounces). It will fit a panel hole 9/16 x 1 11/16-inches. Meter uses a self-shielded magnet, is not affected by magnetic panels. **Triplett Electrical Instrument Co.**, Bluffton, Ohio.

Circle 432 on Page 141



Rotary Transducers

Item 433

Suitable for counting and measuring purposes, line of rotary transducers is designed to convert physical quantities (such as linear or angular position, belt speed, and motor slip) into corresponding voltage pulses. When used with electronic preset counters, tachometers, or frequency counters, the unit provides an accurate visual numerical readout. The same output information can be used to actuate various control functions on equipment such as flying shears, feed chutes, or reels. For linear measurements, unit is supplied with a diameter counting wheel and any number of individual teeth. In illustration, transducer at the left has 1000 teeth, range is from 2 to 10,000 rpm, with the magnetic pickup held in place. The miniature model at the top right is used for applications where lower counts (20) per revolution and high (15,000) revolutions are needed. Miniature unit at the lower right is for 50,000 rpm and higher. **Dynapar Corp.**, 5150 Church St., Skokie, Ill.

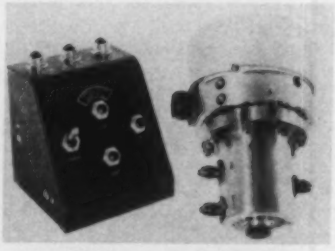
Circle 433 on Page 141

Lubrication System

Item 434

Automatic, electrically operated system is designed to provide high or low pressure centralized power lubrication to industrial machinery. Unit supplies oil or grease to banks of injectors in the system. The system is powered by a ¼-hp motor, will lubricate up to 1000 bearings in seconds. A safety feature is that the system will automatically shut-off if the pump runs dry or a supply line breaks. Alarm devices such as lights, buzzers, or bells can be installed to attract the attention of an operator. Two models of pumps are available, 1000 psi and 2900 psi. **Lincoln Engineering Co.**, 5794 Natural Bridge Ave., St. Louis 20, Mo.

Circle 434 on Page 141

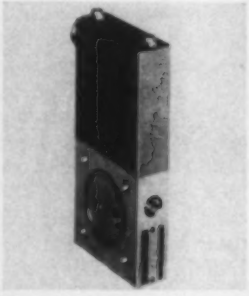


Pressure Regulator

Item 435

Electrically operated pneumatic pressure regulator can be remotely operated, is suitable for systems which require operation at different predetermined pressure level sequences. Model RV-23E is equipped with three 18 to 30 v dc continuous duty solenoids wired to a 3 way switch and a 2 position safety switch. These switches activate the metering valves within the regulator from a remote position. This combination of switches provides infinitely variable pressure over a wide range to be loaded or vented with speed and sensitivity. The safety switch permits fast venting or rapid pressure reducing to almost any desired level. A built-in automatic relief valve and a preset pressure limit valve are included to eliminate the possibility of over-pressurization due to human error, environmental conditions, or power failure. Inlet pressure range is 50 psig to 6000 psig, proof pressure 9000 psig, burst pressure 15,000 psig. Outlet pressure range is 30 psig to 30-200 psig below inlet pressure; proof pressure is 7500 psig, burst pressure 12,000 psig. Rated capacity is 00.1 min. **Marotta Valve Corp.**, P. O. Box 330-44, Boonton, N. J.

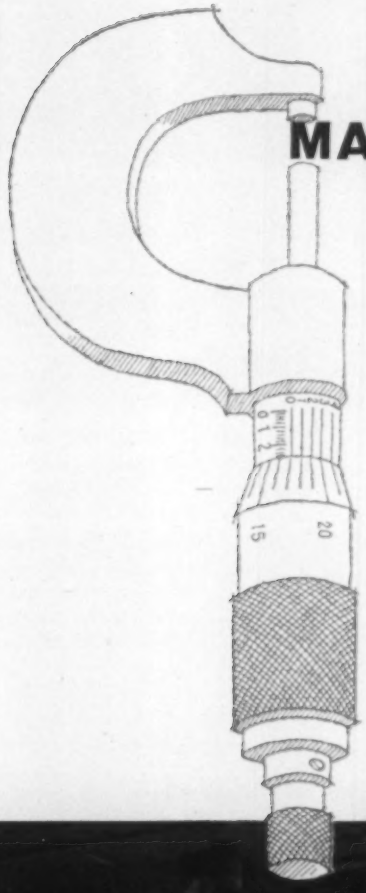
Circle 435 on Page 141



Solenoid Control Valve

Item 436

Unit is suitable for use with air or oil, in pressures to 125 psi, and temperatures to 150 F. Valve can be tapped for ⅛ or ¼-inch pipe connection, is rated at 300 cycles per minute for continuous operation, and up to 700 cycles per minute for intermittent service on air at 120 psig. Units are furnished in normally closed or normally open 3-way and 4-way styles, can be manifolded together in any of four 90-degree positions. When valves are manifolded together, line air passes through each valve, across the sealed counterbore, and on to the next valve, operating eight valves simultaneously from a single supply, or up to sixteen valves simultaneously



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Canco machine shops are located at:

GENEVA, N. Y., North Genesee St. and Lehigh Valley RR • Geneva 8111
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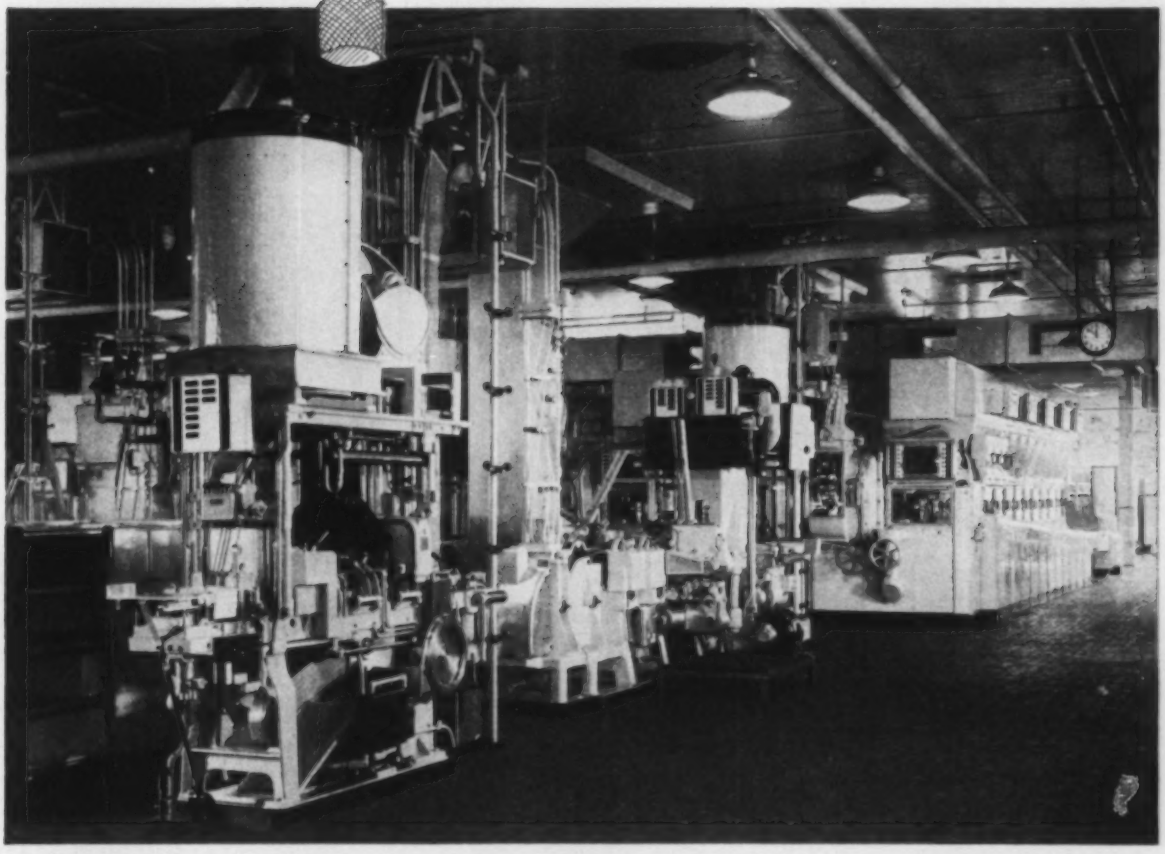
SAN FRANCISCO 10, CAL., 499 Alabama Street • Market 1-5480

These extensive facilities are available to you for contract and sub-contract work. Your inquiry is invited and should be addressed to the machine shop nearest you.

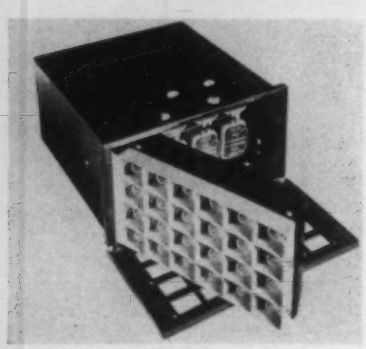
CANCO American Can Company



Circle 693 on Page 141

from two supply lines. **C. B. Hunt & Son Inc.**, Salem, Ohio.

Circle 436 on Page 141

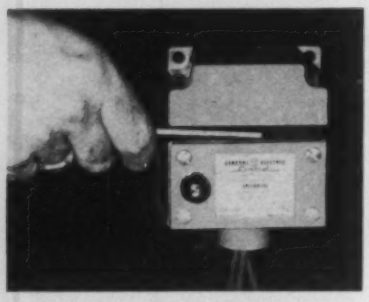


Annunciator

Item 437

Unit is designed for monitoring automatic equipment used in continuous process industries. Annunciator features a flashing sequence and audible alarm whenever an off-normal condition is occurring. Unit is capable of monitoring from 24 to 96 points. When more than 96 points are to be monitored, annunciator systems can be connected to operate in parallel. Compact unit has all plug-in relays hermetically sealed inside the cabinet, does not require field wiring, wireways, or racks. **Panellit Inc.**, 7401 N. Hamlin Ave., Skokie, Ill.

Circle 437 on Page 141

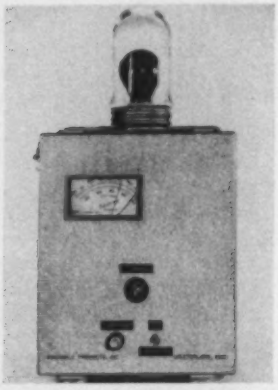


Proximity Limit Switch

Item 438

Unit is capable of over 250,000,000 operations when used with company's static control. Switch has no arms, levers, or shafts; is energized by the passage of a separate metal vane through a recessed slot. Operations remain consistent within ±0.0025 inch if the position of the actuating vane is maintained. Response time is approximately 0.001 second. When attached to the mechanism to be controlled, the vane disturbs a magnetic field balance which causes two small contacts to operate (contacts are located between two permanent magnets). The presence of magnetic dust and chips in the slot and the effect of normal stray magnetic fields will not cause false operation. Switch will operate at any angle, is rated for 115 v ac, 0.2 amp. **General Electric Co.**, Schenectady 5, N. Y.

Circle 438 on Page 141



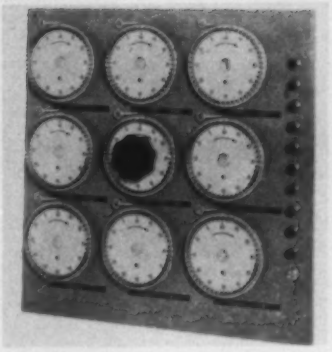
Temperature Scanner

Item 439

Instrument is capable of monitoring as many as 24 stations in sequence. Designed to monitor temperatures from −200 to +3000 F, scanning control will provide similar protection with almost any other measurable variable. The only restriction is that all stations must have the same permissible limits of the condition being monitored. Eitther high or low limits are set on a single meter-relay.

A selector switch, immersed in oil, checks stations in order, at the rate of 12 per minute. An abnormal condition at any point is instantly indicated by a red warning light atop the control, and by an alarm, if this is added. The alarm is sounded if the indicating pointer touches either a high or low limit pointer. If desired, the equipment being monitored can be shut down when trouble is indicated. An interlock keeps the control circuit broken after an alarm until the cause of trouble has been corrected and a manual reset button has been pressed. **Assembly Products Inc.**, Chesterland, Ohio.

Circle 439 on Page 141

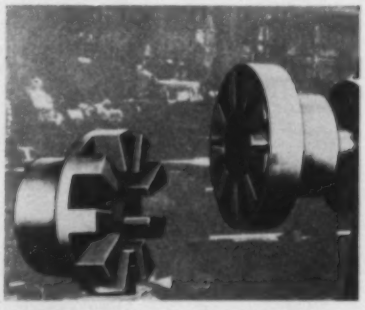


Cycle Timer

Item 440

Suitable as a control for automatic plant operations, multicircuit cycle timer controls the operation of each circuit and the relationship between the circuits in the cycle by master programming dials. All adjustments and settings are made on the face of the panel. Each control has 96 self-contained, nonremovable tripping clips. Adjustments are made by sliding the clips in and out of the dial face. As many as 48 *On* and *Off* operations can be made on any one circuit without disturbing the operation of other circuits. Model WD is driven by one heavy-duty synchronous electric motor. **Zenith Electric Co.**, Dept. ANC, 152 W. Walton St., Chicago 10, Ill.

Circle 440 on Page 141



Heavy Duty Coupling

Item 441

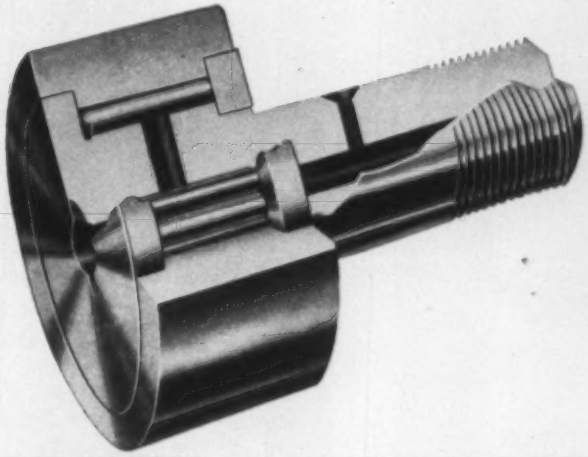
Coupling is constructed for heavy duty, is available in sizes to 4250 hp, with bore sizes to 9½ inches. Coupling features fast installation and easy alignment. Unit can be connected to driving and driven shafts in a few minutes, can be aligned with a straightedge, and does not require a gage. Composition of the body and jaw can be

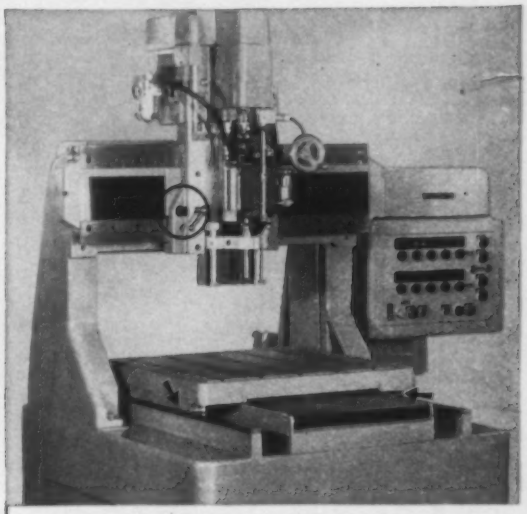
AUTOMATION TIPS
by McGill

CAMROL® bearings... provide automated machinery with precision anti-friction - extra capacity - longer life

Specify CAMROL cam followers where you need dependable, maintenance free bearing performance in automated machine operation. They offer engineered precision with extra protection against jolting wear and excessive loading.

Built especially for cam, guide, support or track roller applications, the McGill cam follower provides free rolling action, positive side thrust and low starting friction — all available in roller sizes from ½" to 4". Order the CF (with stud) and CYR (for shaft mounting) sealed for positive protection.





Sealed CAMROL Bearings as table and crosshead rollers in tape-controlled Hillyer drilling machine

CAMROL bearings provide smooth, accurate motion as load carrying rollers for table and crosshead motion of this tape-controlled, precision drilling machine manufactured by Hillyer Corporation. Use of the sealed CAMROL bearings has greatly simplified construction and improved accuracy. They have eliminated the manufacture of shaft and retainer assemblies and increased load capacities. The corrosion resistant finish of the SCF series bearings has also eliminated the need for plating the bearings. Ball bearings formerly used in this application cracked under the same loads. High accuracy of shaft and bearing concentricity eliminates the need for separate adjustments. Operating speeds are 400 RPM and loads are 2000 pounds. The bearings are prelubricated and sealed to keep maintenance at a minimum.

CAMROL bearings take cam action shock in FMC juice extractors

The Food Machinery and Chemical Corporation In-Line Juice Extractor uses McGill CYR-3 bearings as cam followers on the vertically reciprocating beam that carries cups for squeezing juices from citric fruits. A large cam having an 11" total throw drives against the bearings, moving the beam downward. The CYR 1½ cam followers are used to pull another beam upward. The upstroke is a power stroke with 6" total throws.

Both cam followers have stood up exceptionally well. Many have been in the field for 6 years and operated 20,000 hours, or the equivalent of at least 48 million strokes.

engineered electrical products

McGILL

precision needle roller bearings

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McGILL MANUFACTURING COMPANY, INC., BEARING DIV. 401 N. LAFAYETTE ST., VALPARAISO, IND.

Don't overlook the power of the worm!

H&S

WORM-GEAR SETS insure smooth driving action between perfectly mated members

Check these important advantages for your power transmission needs:

Smoothness of Operation • Ability to Carry Heavy Shock Loads
Compactness • Large Ratios • Reliability
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Horsburgh and Scott worm-gear generating methods guarantee perfect mates in each set, with worm threads and gear teeth having identical pressure angles and tooth contours. Resultant smooth conjugate action delivers maximum right angle power transmission with minimum power loss. H&S gives each set a controlled inspection on the correct center distance for tooth contact, backlash and smoothness.

To meet your requirements H&S makes Worm Gears up to 60 inches diameter—circular pitch range from ¼" to 3½". Ratios can be furnished from 3-5/9:1 to 100:1 . . . For prompt response from H&S engineers, just send an outline of your needs.

THE HORSBURGH & SCOTT CO.
GEARS AND SPEED REDUCERS
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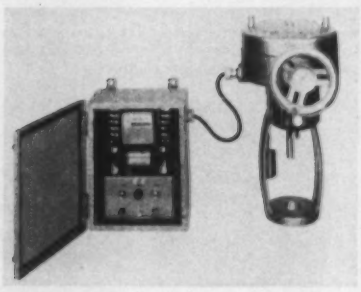
either electric steel or modular cast iron.

The load is transmitted through compression of individual load cushions. This feature permits reversal or advancing of cushions on nonreversing loads. The cushions are visible for inspection, need no lubrication, and can be removed without disturbing the driven units. **Lovejoy Flexible Coupling Co.**, 4984 W. Lake St., Chicago 44, Ill.

Circle 441 on Page 141



Valve Positioner

Item 442

Device is powered by a 1/40 hp, 2-phase, induction-type motor, can operate from a standard electric controller. The positioner does not require auxiliary hydraulic and pneumatic valve-actuating systems. Braking system is designed to prevent valve oscillation and ensure repeatability to within ¼ per cent. Stroke is field-adjustable from ½ inch to 2 inches; stem speed is 0.15 ips, maximum thrust is 1000 lb with a standard gear train. In case of power loss, positioner can be manually operated. **Norwood Controls, Div., American Standard Products**, Norwood, Mass.

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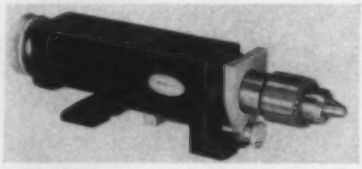

Drill Head

Item 443

Miniature device is capable of drilling, tapping, reaming, spot facing, countersinking, and counterboring. It is especially suitable in the machining of light-gage steel, non-

Circle 695 on Page 141

ferrous metals, and in the working of wood, plastics, and rubber. Drilling capacity is from a No. 80 drill to a 3/6-inch diameter drill in mild steel. Alignment of the drill with the work or fixture is accomplished by a precision keyway which is machined in its base casting.

A built-in air cylinder, with a maximum 2-inch stroke, powers the feed and retract strokes. The positive stop is adjustable through the 2-inch stroke. The self-contained double-acting cylinder provides forward thrust and traverse action through the use of a 4-way control valve operated at air pressures between 20 and 100 psi. Two ⅛-inch pipe ports on the top face of the unit provide air line connections for the control valve. Spindle of the drill head is pulley driven at 8000 rpm. A high speed spindle assembly for 12,000 rpm maximum is available as optional equipment. Model 22A includes the basic unit —pulley, electric motor or chuck are extra. **Bellows Co.**, Akron 9, Ohio.

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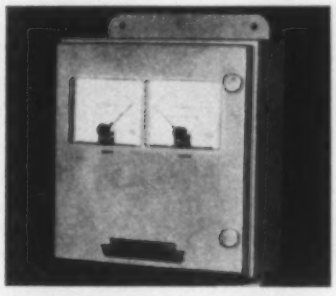


Machine Load Control

Item 444

Device can protect machinery from overload, underload, no-load, and phase failure through automatic shut-off, automatic warning, and continuous on-off automatic operation. Load control is designed with two separate contact ammeters. Each one is equipped with adjustable limit pointers and an indicating pointer. The indicating pointer is activated by a current transformer connected in one of the motor leads. The pointers respond to the current and move identically across the two dials, monitoring and continuously displaying the load on the drive motor. When the indicating pointers contact the

HERE'S WHY SO MANY ENGINEERS SPECIFY P&B's MH RELAY

Shown with printed circuit terminals

VERSATILITY and adaptability are prime reasons why designers have made the MH a P&B best seller for such diverse applications as jet aircraft, street lighting equipment, computers and missile ground controls.

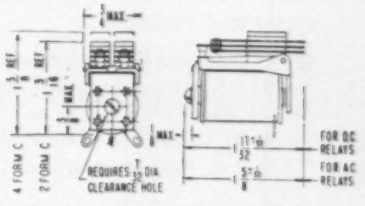
When multiple switching is required ... when size, weight, long life and reliability are critical ... our MH relay can usually fill the bill.

Let us send you complete information. Write or call today.

ENGINEERING DATA/MH RELAY

Insulation: Laminated phenolic.
Insulation Resistance: 100 megohms minimum.
Breakdown Voltage: 500 volts RMS between all elements.
Shock: Up to 30g.
Vibration: Up to 10g from 55 to 500 cps.; .065" max. excursions from 10 to 55 cps.
Ambient Temperature: —45°C. to +85°C. (—65°C. to +125°C. on special order).
Weight: 2½ oz. max. (open relay)
Pull-In: Approx. 75% of nominal voltage.
Pull-In Speed: Approx. 15 ms.
Drop-Out Speed: Approx. 10 ms.
Terminals: Pierced solder lugs; special lugs for printed circuits, taper tab (AMP #78).

CONTACTS:
Arrangements: Up to 9 springs per stack.
Material: ⅛" silver; also Palladium or gold alloy.
Load: Dry circuits to 5 amps @ 115V AC resistive.



COILS:
Resistance: 22,000 ohms max.
Power: 100 milliwatts per movable minimum to 4 watts at 25°C. max. (200 mw. min. to meet max. shock/vibration spec.)
Duty: DC: Continuous. AC: Intermittent (2 pole relay max.)
Voltages: DC: Up to 110 volts. AC: Up to 230 v. 60 cycles.
Current: 2.5 ma to 10 amps DC.

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Circle 696 on Page 141

WITH Lipe Automatic

Magazine Loading Bar Feeds

*says Production Supervisor J. H. Lindsey**

● When we were asked to cut costs to meet or beat competition five months ago, we decided to give the Lipe A.M.L. Bar Feed a try. We had heard that this feeding device enabled screw machines to deliver more than 90% of gross geared capacity. We had never done better than 75% with ours, even when new. In the first full week of bar feed operation, the machine to which the A.M.L. was attached *produced 146% more pieces than it had ever turned out before!*

● The A.M.L. fed stock *continuously*, with no repeat motion for feedouts . . . no down-time for changing feed-fingers, or for remnant disposal. There was no cutting air—and when you stop cutting air, you start cutting costs.

● As a result of this test, we installed an A.M.L. on every screw machine in the production line, with the exception of those we were able to eliminate because of the overall increase in output. When we come to install new machines, the A.M.L.'s will be there to develop *their* extra potential.

Write or Wire for a FREE Lipe Sales Engineering estimate of production increases, savings and amortization time of Lipe A.M.L. Bar Feeds in your production layout.

*Photographer's models and pseudonyms used to protect company identity and confidential information.

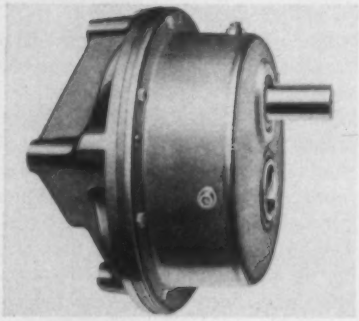
Lipe-Rollway Corporation, Syracuse 1, N.Y.

Manufacturers of Automotive Clutches and Machine Tools

Circle 697 on Page 141

adjustable limit pointers, they actuate the warning and shut-off mechanisms. **Tipptronic Inc.**, Chagrin Falls, Ohio.

Circle 444 on Page 141



Flange Mounted Drive

Item 445

Adaptable for horizontal or vertical applications, gear drive can be bolted directly to the driven machine. Drive is designed with bearing capacities for overhung and thrust loads, can be installed into the machine as a geared pillow block. Unit is available in single reduction for ½ to 10 hp, and in two double reduction ratios for ½ to 5 hp. **Falk Corp.**, Dept. 255, 3001 W. Canal St., Milwaukee 1, Wis.

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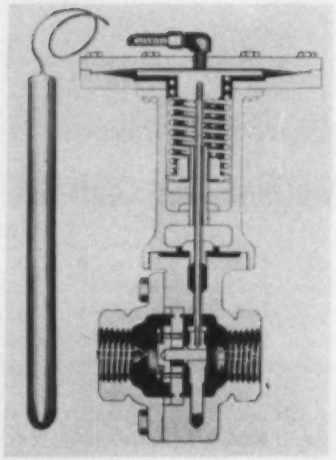

Temperature Valve

Item 446

Suitable for all corrosive applications, temperature control valve features plastic coated sensing bulb, and sliding gate. The thermal bulb and capillary tubing system are coated with a protective, heat con-

ducting plastic film, making it corrosion resistant to a variety of chemicals. Device has ten different temperature ranges from 35 F to 450 F.

The thermal bulb system is charged with a highly sensitive vaporizing liquid. In operation, the bulb is inserted at the point where temperature is to be controlled. Any slight change in controlled temperature will cause the thermal vapor pressure to increase or decrease instantly. The pressure is transmitted through the tubing to a diaphragm chamber. Vapor pressure actuates the diaphragm and valve stem (which moves simultaneously with the diaphragm) thereby actuating the sliding gate to modulate the flow through the valve. **Jordan Industrial Sales, Div., OPW Corp.**, 6013 Wiehe Rd., Cincinnati 13, Ohio.

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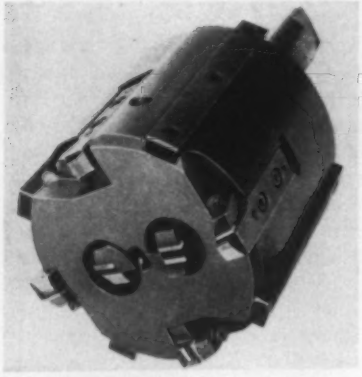

Boring Quill

Item 447

Designed to combine operations such as boring, facing, spot-facing, counterboring, and turning, boring quill features throw-away carbide inserts. The outside-cutting inserts can be adjusted both radially and axially. Close tolerances can be held for each cut individually and for the interrelationships between cuts. By changing the insert holders, the tools can be used on more than one workpiece. **Wesson Co.**, 1220 Woodward Heights Blvd., Detroit 20, Mich.

Circle 447 on Page 141

Cam Limit Switch

Item 448

Unit features adjustable cam lobe assemblies, has a speed rating of up

MISSILE DETECTION SYSTEMS SECTION OF GENERAL ELECTRIC AUGMENTING SYSTEMS MANAGEMENT GROUP

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Write in confidence to: MR. JAMES P. KINSELLA, Div. 11-MV

MISSILE DETECTION SYSTEMS SECTION
HEAVY MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

COURT STREET, SYRACUSE, NEW YORK

Circle 698 on Page 141

NEW
DIXON AUTO-TORQUE Driver

SCREWS AND NUTS
AUTOMATICALLY DRIVEN
WITH PRECISE TORQUE CONTROL

Gives you . . .

1 Complete control of screws from parts feeder to chuck, until threads are started. No dependence on gravity to load chuck.

2 Exclusive built-in sensing, assures that screw is driven. Automatically retracts driver only after attaining proper torque.

3 Complete automatic cycle, requires only a touch of the pedal.

4 Torque accuracy within 5%, comparable to most precise hand-torquing methods.

5 Clutch free-wheels after driving. Operator cannot vary the torque.

6 Two ranges of torque available 0 to 84 inch-pounds and 48 to 120.

7 Work height adjustment with 14" range, can be made without in any way disturbing the machine adjustments.

Model SD-100, above, tooled for any standard screw up to ¼" thread size. Special tooled feeders available. Model SD-101, without floor column, provides a complete automatic station. Maximum width 6 inches.

The new DIXON *Auto-Torque Driver* includes all the features of the DIXON Auto-Positioner, and has an efficient space-saving air motor with an adjustable-torque clutch. These features provide for positive handling, giving new efficiency in driving screws and nuts.

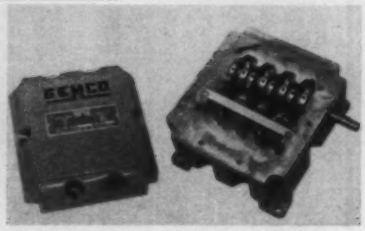
ASK FOR BULLETIN SD-81 illustrating and describing design and operating features and giving specifications.

DIXON AUTOMATIC TOOL, INC.

DIXON 2312 - 23rd AVENUE
ROCKFORD, ILLINOIS

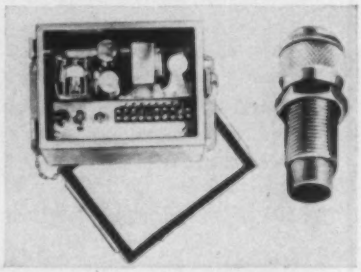
Equipment for Automatic Parts Handling and Assembly

Circle 699 on Page 141



to 400 rpm. One type of cam is suitable for all applications. Adjustments are made by loosening a screw and rotating the cams relative to each other to the desired position. A continuous range of an open and closed circuit can be obtained from 360 degrees down to approximately 8 degrees. Switch is available in 1, 4, 5, 7, and 12 enclosures, two through twelve circuits, high and low speeds. Single pole double throw switch contacts have a 15 amp rating at 115 v, and 5 amp ratings at 440 v. **Gemco Electric Co.**, 25685 W. Eight Mile Rd., Detroit 40, Mich.

Circle 448 on Page 141



Proximity Transducer

Item 449

Device is applicable to various manufacturing operations. It can be used as a sensing element in packaging and conveying functions; and as a control unit in feeding, welding, or drilling operations. Transducer includes: A pickup which is mounted at the point of work, a shielded connecting cable, and a control unit. The presence of metallic workpieces in close proximity to the pickup causes the connected control unit to provide an electrical pulse which regulates mechanical or electronic production operations.

In operation for a feeding appication, the unit is installed on the feed track around a vibratory bowl feeder. The system shuts the feeder off when parts reach an optimum level and turns it on again when the level of the parts is below the level desired. For complex operations, two or more transducers can be used. **Electro Products Laboratories**, 4500 N. Ravenswood Ave., Chicago 40, Ill.

Circle 449 on Page 141

Drum Switch

Item 450

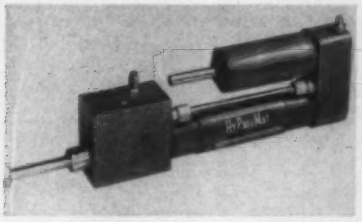
Device is capable of starting, stopping, and reversing small ac and dc motors. The switch mechanism is mounted separately from the enclosure, so that external forces which may distort the enclosure cannot cause binding in the switch. The Bulletin 350 has a wrap-around cover which exposes the switch mechanism for easy wiring. Other features include: The terminal screws are accessible from the front, the edge of the enclosure base is raised so that the wrap-around cover can be slipped on or off directly from the front, and the oiltight cover is provided with a rubber flange gasket and O-ring seals on the shaft to exclude oil and coolants. Drum switch is available for 1½ hp, 110 v; 2 hp, 220 v, single phase motors; 2 hp, 110-220-550 v, polyphase motors; and ¼ hp, 115-230 v, dc motors. **Allen Bradley Co.**, 136 W. Greenfield Ave., Milwaukee 4, Wis.

Circle 450 on Page 141

Checking Cylinder

Item 451

Self-contained unit is designed to provide an external hydraulic control of feed rate on various types of tools or cylinders. It is mounted adjacent to or in line with the tool or cylinder to be controlled. A cam, attached to the tool or cylin-



der exerts a pull force on the unit. Model HB-125 has stroke lengths from 3½ to 12 inches, with a checking load of 1200 lb. A feed adjusting needle valve provides the feed control needed. Construction features include: Rapid return rate, replaceable actuating rod, and replaceable bronze piston rod bushings. Unit can be mounted on its base, side, or nose. **Hypneumat Inc.**, 647 W. Virginia St., Milwaukee 4, Wis.

Circle 451 on Page 141

Electronic Counter

Item 452

Portable 4-digit or 5-digit electronic unit is capable of counting, totalizing, and measuring time intervals. Counting rate is 1 to 120,000 events per second with direct reading in cps or cycles per 1/10 second. Accuracy is ±1 count; input voltage is from 0.2 v rms to 200 v rms. Gate times are 1.10 and 1 second; display time is continuously adjustable from 1/10 second to 15 seconds. Other features of Model 1610 include: a sensitivity control which eliminates noise effects, a self-test which permits counting of the time base signal, and an automatic reset at the end of the count capacity. **I-L-S Instrument Corp.**, 4526 W. 160th St., Cleveland 35, Ohio.

Circle 452 on Page 141

BALDOR

Streamcooled MOTORS

BALTRIC LINE

For general use or for specific applications demanding the most exacting requirements, the Baltric line of motors more than fills the bill. One reason is the "Monocast" Stator shown above.

Steel laminations in an aluminum alloy casting form a stator frame of greater stability . . . greater rigidity. This permits the use of a new and better slot design. The result is uniform magnetic flux distribution throughout the motor—gives more power, greater efficiency, higher power factor and quieter operation.

If you're interested in getting top efficiency from your equipment while holding costs to a minimum, investigate the Baltric line of motors—without obligation! Just write . . .

BALDOR

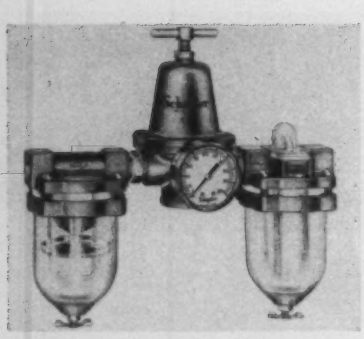
ELECTRIC COMPANY

4355 Duncan Avenue • St. Louis 10, Missouri

Over 500 Authorized Sales & Service Distributors in U. S. A.

District Offices: Atlanta • Chicago • Cleveland • Dallas • Dayton • Des Moines • Detroit • Litchfield, Conn. Los Angeles • Milwaukee • Minneapolis • New Orleans • New York • Kansas City, Mo. Oakland • Philadelphia • Portland, Ore. • Syracuse.

Circle 700 on Page 141

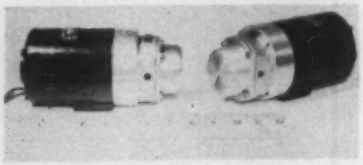


Air Line Control

Item 453

Equipment can filter, regulate pressure, and lubricate air in lines; is applicable on control instruments and air tools. Combination has no moving parts, can be serviced without disturbing pipe connections. Filtering is accomplished by corrosion-resistant components; the sintered bronze filter produces a minimum pressure drop, can be removed for cleaning. A drain cock blows out foreign material. Whirling action throws water and foreign materials to the sides and bottom of a transparent bowl. The bowl is constructed for pressures up to 150 psi; for higher pressures and extreme temperatures, a metal bowl is available. The regulator adjusts outlet pressure from 5 to 125 psi by a turn of the handle. The automatic lubricator provides for the adjusting of oil flow. The body and all interior parts resist corrosion and can be replaced. The filter, regulator, and lubricator are available separately, in combinations of two, or as an entire assembly. Pipe sizes are 1/4, 3/8, 1/2, 3/4, and 1 inch. **A. Schrader's Son, Div., Scovill Mfg. Co. Inc.**, 470 Vanderbilt Ave., Brooklyn, N. Y.

Circle 453 on Page 141

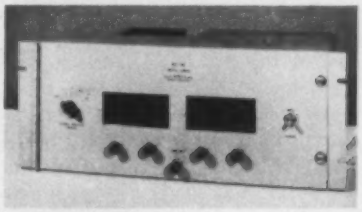


Pump & Motor

Item 454

Designed for hydraulic equipment, pump and motor combination can operate from a 12 v battery, requires no more space than a conventional motor. Model AKX is rated for 30 cubic inches per minute at 500 psi. It uses 10-W lubricating oil as a hydraulic fluid. Operating temperatures can be up to 200 F. Motor is rated for 1/8 hp. **Tuthill Pump Co.**, Dept. RP, 939 E. 95th St., Chicago, Ill.

Circle 454 on Page 141



Digital Clock

Item 455

Model DC-104 provides a digital output in the form of contact closures representing the time of day (in hours and minutes). Visual readout is by means of an in-line digital display mounted in the front panel. The clock has a continuous operation and features individual *Time Set* pushbuttons below each display window. This permits each digit to be independently set. A rotary switch mounted on the front panel provides a means of selecting an automatic readout at desired intervals. Interlock contacts lock the clock in position so that during printout there is no loss of timing accuracy. Unit is rated for 115 v, 60 cycle. **G. M. Giannini & Co. Inc.**, 1307 S. Myrtle Ave., Monrovia, Calif.

Circle 455 on Page 141

Miniature Amplifier

Item 456

Control source of miniature magnetic amplifier can be as little as 5 milliwatts of power, but it can control the flow of power from a 400-cycle source to a load of up to 12 w, ac or dc. Designed for printed circuit boards, or stacking on a single screw for chassis mounting, unit is applicable for dc motors and 2-phase motors, regulated power supplies, relay drives, and solenoid valves. When external rectifiers are used, power gains of up to 5000:1 can be obtained. Unit is supplied

NEW AGASTAT®

HAS LONGER OPERATING LIFE

The Agastat time/delay/relay has been completely re-designed, inside and out, to make every moving part last longer and operate more reliably. Here are some other important advantages:

- Dial adjustment for ease and accuracy
- Five timing ranges, covering an overall range of from 0.08 seconds to 15 minutes
- Timed intervals remain the same through repeated readjustments
- Integral wiring diagram and calibration plate
- Measures only 4-9/16 x 2-9/16 x 2-5/8"
- All contacts are flexible contacts
- Contacts are larger for fast heat dissipation

Write for details and application engineering assistance to Dept. A32-1023.

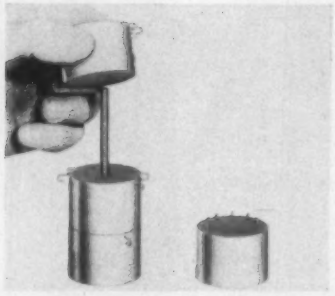
AGA DIVISION

Elastic Stop Nut Corporation of America

1027 Newark Avenue, Elizabeth, New Jersey

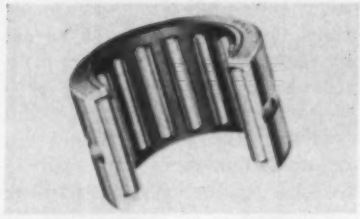
Pioneers in Pneumatic Timing

Circle 701 on Page 141



with output voltages ranging from 30 to 300 v ac or dc. Control voltages range from 0.70 v dc to 20 v d.c **Arnold Magnetics Corp.**, 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 456 on Page 141

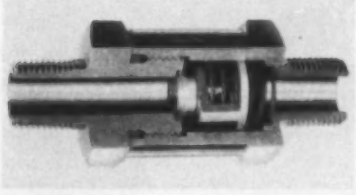


Caged Needle Bearing

Item 457

Unit is designed to provide adequate capacity where excess misalignment prevents using a larger bearing. The cage type needle roller bearing can be interchanged dimensionally with heavy duty needle bearings, is available with or without separable inner races. A one-piece, channeled outer race contains a single row of rollers in a continuous steel cage. Outer ring and rollers are through hardened and precision ground. Black oxide finished cages guide rollers at the pitch line. **Bearing Div., McGill Mfg. Co. Inc.**, Valparaiso, Ind.

Circle 457 on Page 141



Check Valve

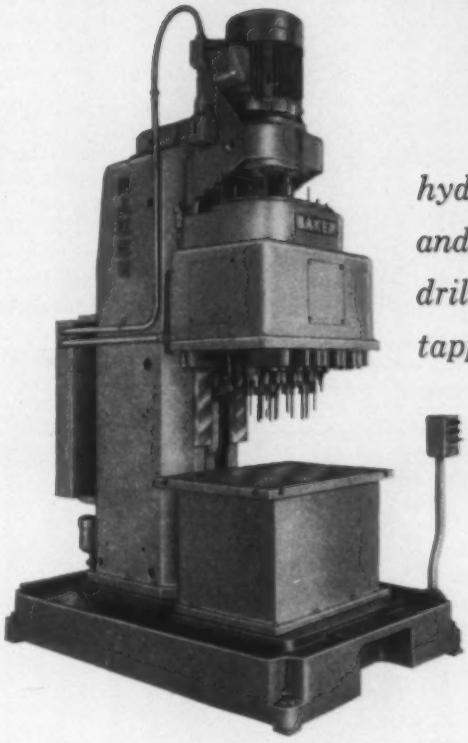
Item 458

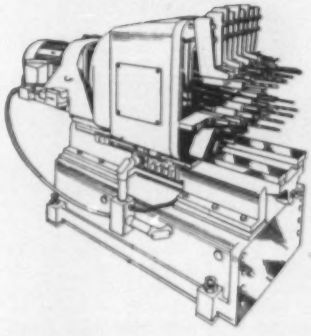
Unit is suitable for liquids, vapors, and gases which function at

new!

BAKER®

hydraulic vertical and horizontal drilling and tapping machines





WITH NEW STANDARD ADJUSTABLE SPINDLE HEADS

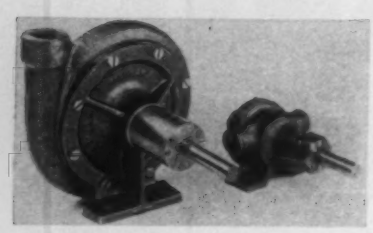
They're here! The new full line of standardized Baker basics—most versatile machines available. Advanced design assures minimum maintenance, permits fastest retooling using standard components. Write for new catalog and name of nearest Baker representative.

BAKER BROTHERS, INC., TOLEDO 10, OHIO

Circle 702 on Page 141

pressures from zero to 3000 psi. Valve is designed so that low pressures seat the poppet on a resilient disc inset in the body. As pressures increase, the rubber disc is radially diplaced and a metal-to-metal seal results. Valve is available in pipe sizes from ¼-inch through 4-inches and tubing sizes from ¼-inch through 1½-inch. **Sealol Corp.**, Providence, R. I.

Circle 458 on Page 141



Stainless Steel Pumps

Item 459

Centrifugal (left) and impeller type (right) pumps are applicable in the chemical process industry or wherever a pump with a good resistance to corrosion is required. The shaft, body, and cover of the centrifugal pump are constructed of acid-resistant stainless steel, and sealed ball bearings are used. Rotary faces of either carbon or glass filled Teflon composition are available. The stationary seats are also of stainless steel and are ceramic faced. When caustics are to be pumped, stellite seats can be supplied. The pump has reinforced pipe ports of 1¼-inch inlet and 1-inch outlet, can be used with motors from 1/3 to 3 hp to deliver 56 gpm at no head to 75 gpm with 90-ft heads.

The impeller type pump is designed to prevent contamination of the materials handled, is self-priming, and will pass small solids. Unit features easy dismantling for servicing or inspection. Carbon bearings and *U* cup type seals are used. This pump is available in models rated ½ and 1 hp to deliver 10 gpm and 25 gpm. It will accommodate a temperature range from 35 to 150 F and will handle a wide variety of materials. **American Machine Products Inc., Sales Dept.**, 172 Centre St., New York 13, N. Y.

Circle 459 on Page 141

How fast do you want to drill...

10,000 RPM MAYBE 15,000 OR 20,000 ?

Oil-circulating head with vertical adjustment spindles.

U. S. Drill Heads are designed to drill as fast as you need—*and still maintain accuracy!*

The rugged Fixed Center Head shown is a full ball bearing, oil-circulating model with built-in pump. It operates regularly in production at 15,000 rpm with very little heat! As in all U. S. Heads, shaved gears assure quiet, smooth operation—at all speeds. Write for catalog FC-57.

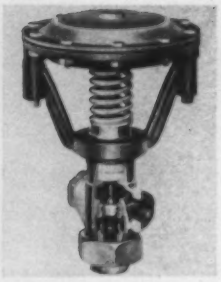
US DRILL HEAD

Adjustable and Fixed Center Multiple Drilling Heads. Individual Lead Screw Multiple Tapping Heads.

UNITED STATES DRILL HEAD CO.

BURNS STREET • CINCINNATI 4, OHIO

Circle 703 on Page 141



Control Valve

Item 460

Suitable for use in water, steam, air, or gas, 350 psi valve (cutaway view shown) is diaphragm-operated. Unit features a one-piece stainless steel stem with integral seats and replaceable hardened seat rings. The valve seats can be easily removed for inspection or maintenance. Valve is furnished in 3-way or reverse acting types. Available sizes are: ½-inch inlet, cylinder and drain ports, or ½-inch inlet with ¾-inch cylinder and drain ports. A top diaphragm unit is also available, is actuated by 20 to 35 psi, can be operated by any pneumatic or electro-pneumatic cycle control device. **Sinclair-Collins Valve Co.**, 454 Morgan Ave., Akron 11, Ohio.

Circle 460 on Page 141

Time Switch

Item 461

Device is capable of controlling irregular operations such as commercial heating and ventilation. Switch has 96 self-retaining trippers in a 24-hour dial. Operation for any fifteen minute period throughout the day is obtained by sliding the tripper in or out with the fingers. A Sunday or holiday cutout attachment is available to gear the drive to prevent it from

getting out of synchronization. Switch is rated for 10 amps, 120 v; or 5 amps 240 v. Unit is furnished with a weather resistant breather case for indoor or outdoor use. **Paragon Electric Co.**, Two Rivers, Wis.

Circle 461 on Page 141

Air Line Lubricator

Item 462

Feature of Model A606 is that it is automatically filled. This feature reduces maintenance and downtime. A built-in float mechanism automatically maintains a constant oil level in the lubricator bowl when fed by an oil supply line with pressure from 10 to 100 psi greater than the air pressure applied to the lubricator. Unit is available in ¼, ⅜, ½, ¾, and 1-inch sizes. **Industrial Div., Watts Regulator Co.**, 10 Embankment Rd., Lawrence, Mass.

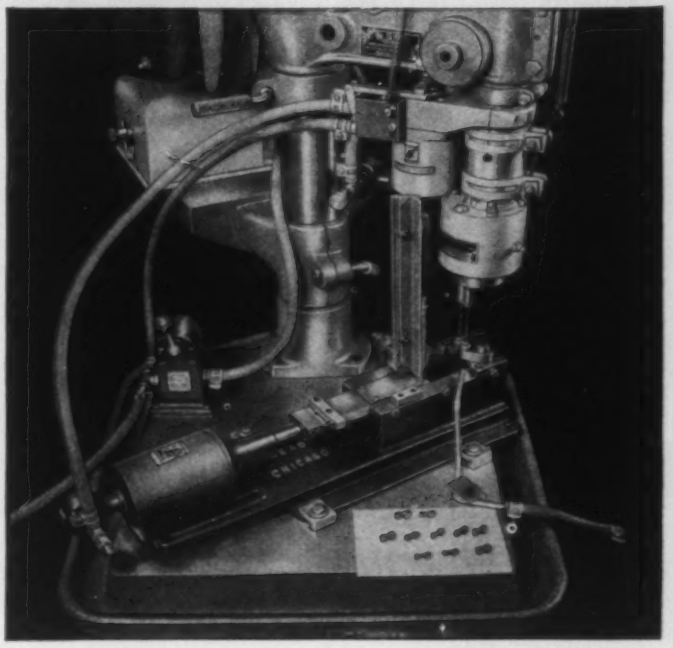
Circle 462 on Page 141

Electric Counter

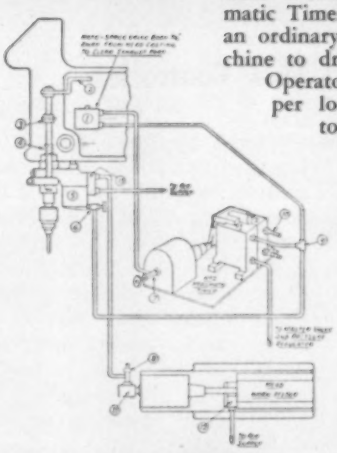
Item 463

Six digit electric counter features two - hundred - million - count life. Model CE-800 is enclosed in a dust-proof container, has a built-in silicone diode full wave bridge rectifier with capacitor. A conduit opening

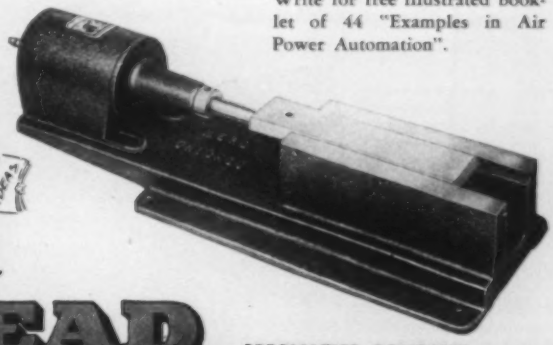
AUTOMATION WITH AIR POWER



This Work Feeder, with the aid of a Meadmatic Timer and Drill Press Feed, transforms an ordinary drill press into an automatic machine to drill twin holes in Chain saw links. Operator merely keeps the vertical hopper loaded—the machine delivers them to the drills, holds them firmly and ejects them when finished. Material is tough alloy steel, ranging in thickness from ⅛" to ¼". Hole spacing is held to 0.0005" by bushings mounted in plate with micro adjustment. Production is 600 to 900 per hour, depending on thickness.



Write for free illustrated booklet of 44 "Examples in Air Power Automation".



MEAD SPECIALTIES COMPANY

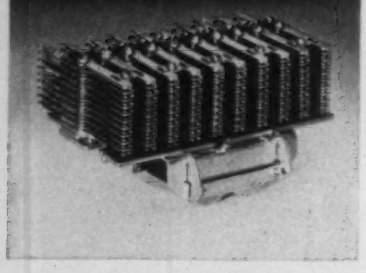
4114 North Knox Avenue, Dept. A-108, Chicago 41, Ill.

PATHFINDER IN AIR POWER AUTOMATION

Circle 704 on Page 141

STROMBERG-CARLSON

"BB" Series Relays



For your automation ...computing...control circuit applications... "Telephone Quality" at an ordinary price

To meet your needs for precision and durability in automation, computing and control circuitry, this relay provides *telephone quality* at an ordinary price.

The "BB" Series Relay accommodates up to 100 Form A spring combinations. It incorporates such important advantages as twin contacts, knife-edge pivot and special frame-armature construction. Like all Stromberg-Carlson relays, it is built to operate under extreme ranges of temperature and humidity. *Prompt delivery is available on all orders.*

This catalogue will give you complete technical details and specifications. We will gladly send you a free copy on request. Please ask for Catalogue T-5000R.

S-C

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

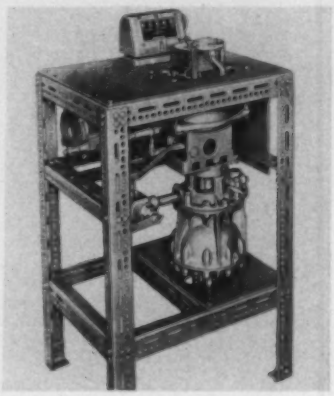
TELECOMMUNICATION INDUSTRIAL SALES

111 CARLSON ROAD, ROCHESTER 3, N. Y.

Circle 705 on Page 141

with separate wiring compartment permits wiring without breaking the dustproof enclosure seal. Unit has a production rate of 1000 counts per minute, is available with knob or key reset. When mounted, the assembly screws are inaccessible, protecting the counter against tampering. Unit is rated for voltages up to 230, for 25, 40, and 60 cycles. **Production Instruments Div., General Controls Co.**, 8078 BPH McCormick Blvd., Skokie, Ill.

Circle 463 on Page 141



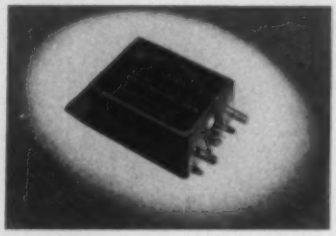
Flow Controller

Item 464

Unit is applicable for all liquid handling operations which require accurate control of the rate of liquid flow within ¼ of 1 per cent accuracy, regardless of variations in pump pressures or liquid viscosities. Components in the controller include selector dial, rate of flow chart, motor, control nut, meter, speed reducer, chain drive, and counter.

The speed motor, meter, valve, and variator are synchronized through the use of the control nut assembly, and this provides the positive control of the flow rate. In operation, the motor shaft rotating at the same number of rpm's as the meter cap shaft connects to and drives the variator. The variator is equipped with a selector dial which enables selecting any percentage of the meter's flow range in increments of ½ per cent to 100 per cent. The variator output shaft which is now rotating at the desired preset speed connects to the control nut assembly which in turn connects to the meter cap shaft and the flow control valve. The control nut provides synchronization of both shaft speeds and the flow passing through the valve. Controller is capable of handling all types of liquids; for corrosive chemicals, a stainless steel meter can be furnished. Capacities ranging from ½ gpm to 250 gpm can be controlled. **Meter Div., Bowser Inc.**, 1300 E. Creighton Ave., Fort Wayne, Ind.

Circle 464 on Page 141



Miniature Amplifier

Item 465

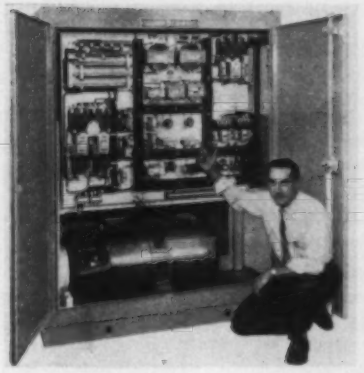
Miniature device is capable of delivering a maximum power of 2.5 w, is suitable for high-speed applications where the amplifier can be mounted inside individual servo cans beside other components with which it is associated. Gain of the amplifier is established by inserting one external resistor to achieve the gain desired. If one unit is interchanged for another, gain tolerance between interchanged units will not exceed ±12 per cent. The transistorized servo amplifier operates through a chassis operating temperature range of —55 C to +110 C. Throughout that temperature range, gain stability is within ±2.5 db, power gain is 62 db, and voltage gain is adjustable between 43.5 db to 58 db by means of an input resistor. **Kearfott Co. Inc.**, 1378 Main Ave., Clifton, N. J.

Circle 465 on Page 141

Adjustable Speed Drive

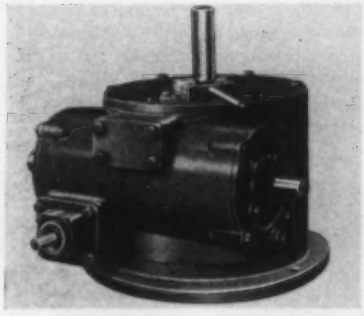
Item 466

Motor-generator type adjustable-voltage drive is applicable on machine tools, printing presses, test stands, slitters, conveyors, and tube mills. Reliability is assured through the use of transistors, magnetic amplifiers, metallic rectifiers, and static units. Drive is available in ratings from 3 to 200 hp for single or multimotor applications. Speed ranges up to 8 to 1 by armature voltage



control are furnished. Additional speed ranges by armature voltage control and by motor field control are also available. **Square D Co.**, 4041 N. Richards St., Milwaukee 12, Wis.

Circle 466 on Page 141



Indexing Drive

Item 467

Cam-operated indexing unit is capable of precision positioning between automatic production stations. It is applicable on operations such as machining, milling, drilling, punching, soldering, and crimping. Dial plates and tooling plates can be easily attached. In operation, each revolution of the cam shaft rotates the dial plates or index shaft through one index. A major portion of the rotation is used for dwell or work time, and the balance for positioning to the next index. One turret cycle can produce 8, 12, 16, or 20 indexes. Work time can be ¼, 1/3, or ¾ of each index cycle. Unit can operate with the index shaft in vertical or horizontal position. **Standard Tool & Mfg. Co.**, 237 Laurel Ave., Kearny, N. J.

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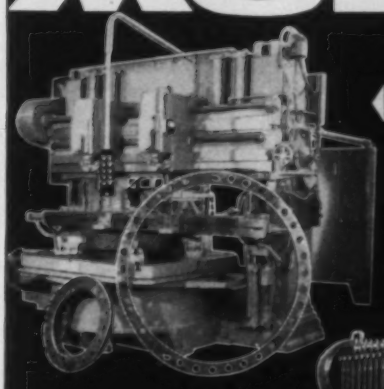
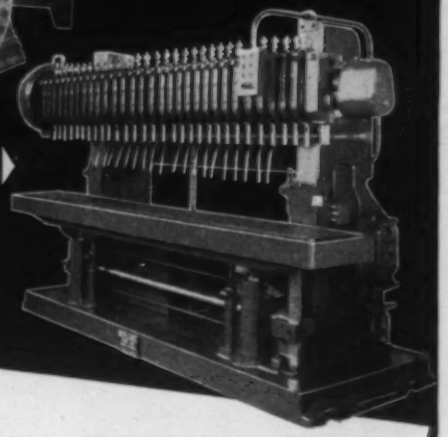
MOLINE



HD68 drills bolt circles from 12" to 100" diameter. Each of the two spindles has capacity for 2½" drill in steel. Operating cycle is fully automatic.



HD13 straight line-type drilling machine with capacity for thirty ¾" drills in steel. Used for work on heavy castings, round and rectangular steel tubes, structural shapes, plates and grader blade drilling or countersinking.

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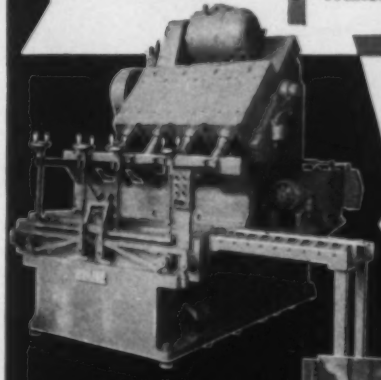
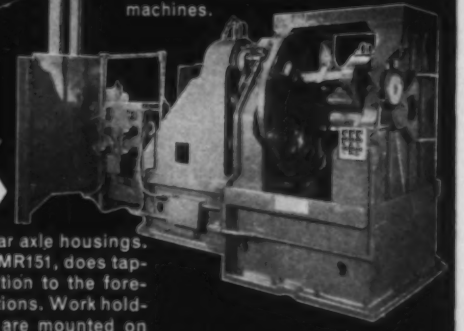


13CB hydraulic feed cylinder boring machine. V-8 engine blocks are rough and finish bored for wet-type cylinder sleeves. Units of this kind are applicable for transfer machines.



MR152 performs drilling, reaming, spot facing and chamfering operations on tractor rear axle housings. A companion machine, MR151, does tapping in addition to the foregoing operations. Work holding fixtures are mounted on power driven trunnion.

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Circle 706 on Page 141

NATIONAL ELECTRIC

solves tough production problem of welding air-suspension brackets for 1958 cars

The new air suspension systems introduced on some 1958 cars, create not only a super-smooth ride for passengers . . . but many production problems for manufacturers. To help lick one of these problems . . . National Electric designed and built two new multi-station arc welders that perform 2 important operations on the structural members of the new systems.

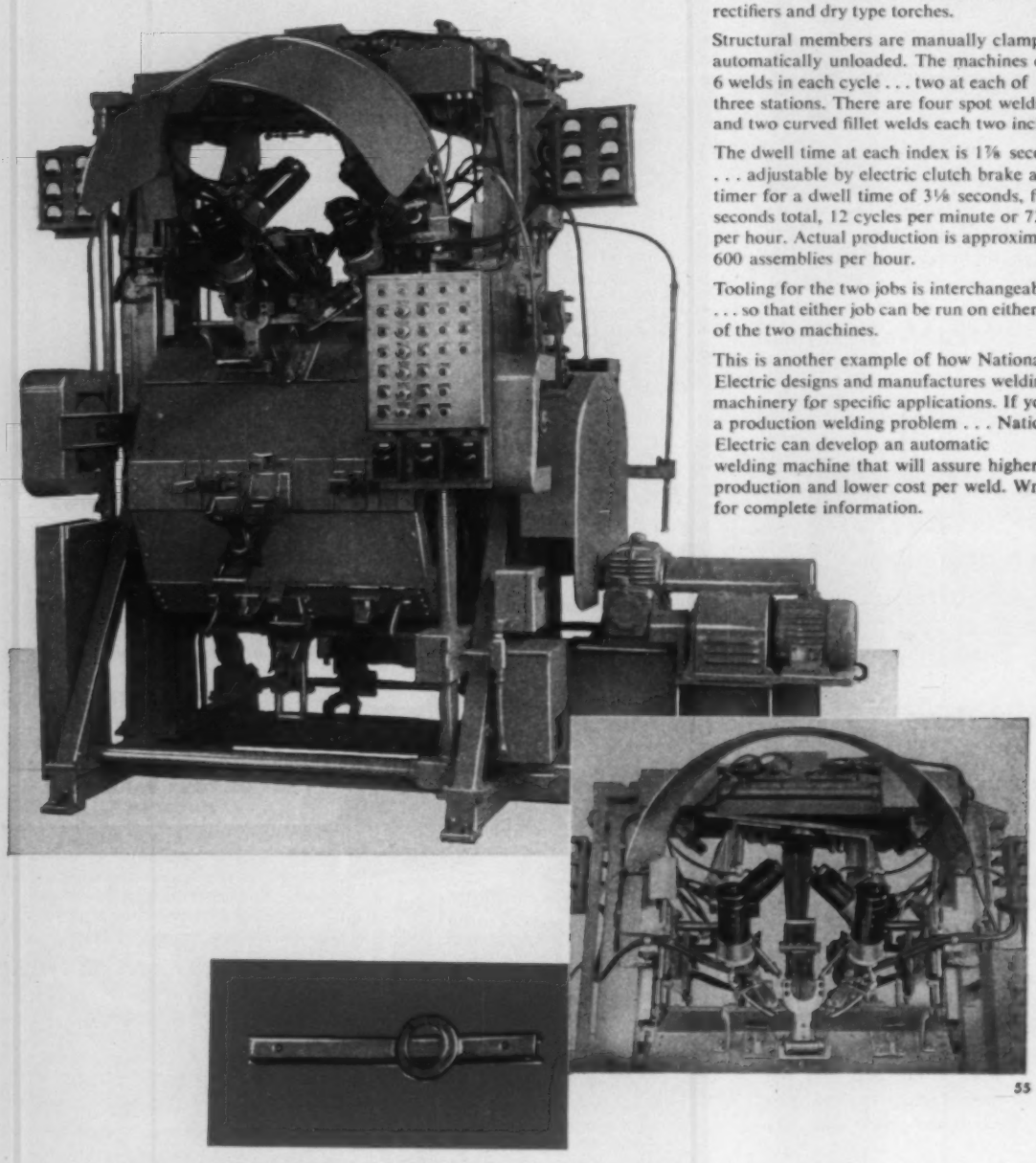
These 6-head, CO_2 arc welders incorporate a drum feed, 8-station Geneva Index, with 800 amp. rectifiers and dry type torches.

Structural members are manually clamped and automatically unloaded. The machines complete 6 welds in each cycle . . . two at each of three stations. There are four spot welds . . . and two curved fillet welds each two inches long.

The dwell time at each index is 1⅞ seconds . . . adjustable by electric clutch brake and timer for a dwell time of 3⅛ seconds, five seconds total, 12 cycles per minute or 720 cycles per hour. Actual production is approximately 600 assemblies per hour.

Tooling for the two jobs is interchangeable . . . so that either job can be run on either of the two machines.

This is another example of how National Electric designs and manufactures welding machinery for specific applications. If you have a production welding problem . . . National Electric can develop an automatic welding machine that will assure higher production and lower cost per weld. Write for complete information.



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Circle 707 on Page 141

AUTOMATION abstracts

PROTECTING SHOP AIR LINES AGAINST MOISTURE AND DIRT

By DON W. BENNER
Wilkerson Corp.
Englewood, Colo.

PNEUMATICS occupies an important position in the modern machine tool industry. Automation, which frequently depends on it, has enhanced its value as a shop necessity. Machine tools alone employ air for a wide variety of jobs: To operate chucks, clamps, feed mechanisms, valves, switches, air motors, and cylinders; to convey lubricants, coolants, and other fluids; to gage parts; to cushion machine actions; to create vacuums; to blow off parts; and to act as a coolant.

While hydraulics is best for some applications, pneumatics has many advantages of its own. For example, air is less costly to install and maintain than hydraulics. When it leaks, air doesn't cause a safety hazard or a housekeeping problem. In fact, its audible hiss often functions as an automatic leak detector! With hydraulic coolant and lubrication circuits, a pump is usually provided for each machine. This multiplies the maintenance problems and initial costs involved. Separate compressors are not needed on each machine for equivalent pneumatic circuits.

Unfortunately, pneumatic systems are not always accorded the same care given to hydraulic systems. Put dirty oil in the hydraulic system of a machine tool, for example, and the results are soon known. Machine tool builders carefully build into their equipment the best possible protection against this costly condition—they recognize that the reputation and success of their products is dependent upon clean hydraulic oil.

Just as hydraulic systems can be protected against contaminants, so can pneumatic systems. Machine tool manufacturers must give as much attention to filtering, controlling, and lubricating pneumatic systems as they do to their hydraulic circuits. Numerous component suppliers are devoted to helping this cause with products designed for the purpose.

Begin At Intake

Clean, compressed air begins at the intake to the customer's supply system. However, the machine tool builder has no control over this. When he designs, he can provide protection only from the point at which air enters his machine. Thus, the user is cautioned to inyestigate his own shop air supply system, beginning at the compressor intake.

Does the compressor suck in heated air from a nearby furnace? Does it bring in extra moisture from a nearby steam process? Does it suck in dirt from a nearby cleaning or machining operation? Is it equipped with an efficient filter, and is the filter cleaned regularly? There are approximately 865 million dirt particles in a cubic foot of industrial atmospheric air, each of which is a potential source of trouble.

System Considerations

If a single-stage compressor delivers adiabatically compressed air to a receiver at 100 psi, roughly 9½ cubic feet of atmospheric air is reduced to 1 cubic foot. Included in each cubic foot of compressed air may be dirt, fumes, and moisture. A cubic foot of ordinary atmospheric air at an ambient temperature of 70 F and 60 per cent relative humidity contains about 0.035 pounds of moisture. Thus, when com-

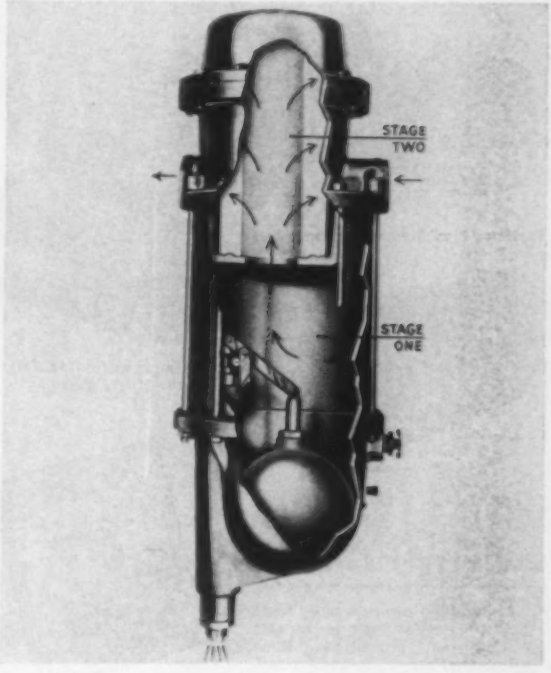

Fig. 1—Two-stage separator/filter used in pneumatic air supply lines. Condensed moisture and large dirt particles are automatically removed in first stage of unit, and smaller particles and oil fumes are trapped by filter in second stage.

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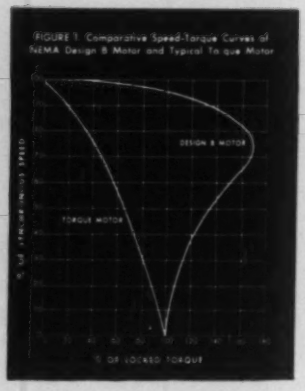
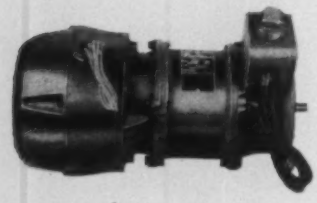
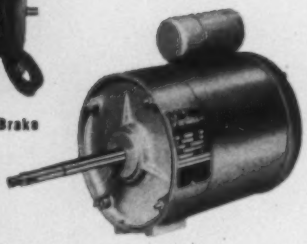


FIGURE 1. Comparative Speed-Torque Curves of NEMA Design B Motor and Typical Torque Motor
DESIGN B MOTOR
TORQUE MOTOR
% OF LOCKED TORQUE

The speed-torque curve varies from that of a conventional motor. The torque motor curve is almost linear. Maximum torque occurs at the stalled position. For this reason, torque motors are used most often where a holding or resisting force is required.



Explosion-Proof Torque Motor With Brake



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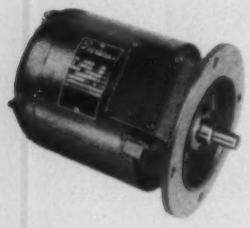

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pressed, each cubic foot of air in the receiver will contain about 0.33 pound of moisture. In a 100 cubic foot capacity receiver, this comes to about 33 pounds. If permitted to get to a machine tool, the effects of this moisture and dirt can be imagined. An automatic tank drain that periodically purges the receiver is an effective aid at this point in the system. Besides removing moisture and contaminants, this device maintains the receiver at full capacity. It thus prevents the compressor from running too long and too often, consuming unnecessary power and causing undue wear.

Not all of the moisture and contaminants are removed at the receiver, however. Some still remain in suspension and pass through the lines. Aftercoolers are sometimes used at the receiver exit, but these do not remove solid particles, fumes, or compressor oils. These must be filtered out. A better solution is to locate a combination separator/filter equipped with an automatic drain in the main line after the receiver. By locating this device as far as possible from the receiver, some cooling action will occur in the line. A separator/filter, *Fig.* 1, is a two-stage unit. In the first stage, cooling induced when air enters the unit assists condensation of moisture. Large dirt particles also settle out in this stage, and both are removed automatically as they accumulate. Relatively clean and dry air then passes through the second stage of the unit where an absorbent filter element strains out small dirt particles and oil fumes.

As further cooling can occur beyond the point at which the separator/filter is installed, an inexpensive automatic separator should be placed at each point where air is taken from the system. This will remove any additional condensation, pipe dope, and scale that may be present.

Equipment Builder's Responsibility

The good machine builder cannot afford to design his machine on the basis that all of his customers have employed good pneumatic practice. Instead, he should provide his own insurance against damage to his machine by dirty air. Since long warranty periods usually apply to machine tools, needless expense to the builder could easily result from his failure to adequately protect his equipment.

A filter should be installed at the input to the pneumatic circuit of the machine. Automatic filters are best, because the customer may have manual-drain units in his system which are neglected. If the machine is a large one, such as a transfer machine, supplementary filters may be required at several of the stations because of cooling that occurs in the machine's air lines. The filter at the main air connection of such a machine should always be a float-operated automatic drain type, while the supplemental filters may be less costly piston-operated automatic types.

Air pressure regulators are important on many pneumatic circuits. The tamper-proof adjustment type is best to prevent unauthorized personnel from changing the settings. This type costs no more than the regular one. These devices control the speeds and feeds of air cylinders and the forces of clamps and chucks.

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They reduce the consumption of air in blow-gun operations and reduce the possibility of accidents caused by chips and dirt being blown too forcibly through the air. The small amount of air pressure required to clean is not realized by most people. Air regulators should be set by the machine user at a pressure equal to the lowest shop main line pressure so it will remain at that pressure even though shop air pressure rises during low air consumption periods. This will eliminate fluctuations in machining and other operations controlled by the air.

Air line lubricators should be included in a pneumatic circuit which includes air cylinders, clamps, chucks, feed mechanisms, and positioners to keep them operating freely, reduce wear, keep packings pliable, and protectively coat metal surfaces against corro-

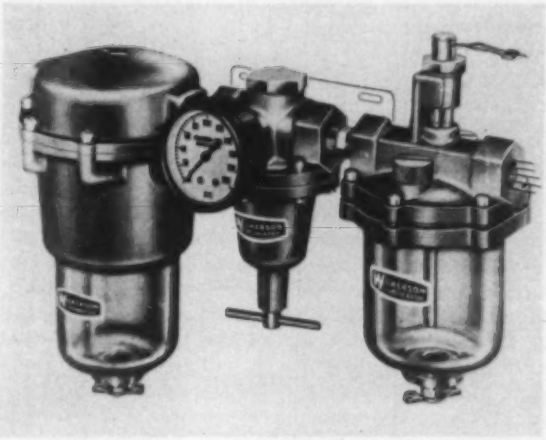

Fig. 2—Combination unit includes filter, pressure regulator, and automatic lubricator. Units of this type are suitable for connection at inlets to machine pneumatic systems.

sion. An air line lubricator should be one that can be filled without shutting off the air line. It should have a sight flow gage so the operator can see that lubricant is entering the air line, and at what rate. The lubricator should have a fill hole located conveniently for filling. Because there are so many small cylinders and clamps operated by air, the ideal lubricator would be one that gives lubrication down to ½ or 1 cfm flow of air to insure lubrication. The bowl of the lubricator should have a petcock so any moisture that collects in the bottom can be drained. Here, again, a tamper-proof adjustment knob is usually best. A combination filter, pressure regulator, and air line lubricator is shown in *Fig.* 2.

When factory managements and machine tool builders strive together to provide clean, regulated, lubricant-carrying air, both groups will enjoy fully the benefits of this useful powering medium.

From a talk entitled "Pneumation of Machinery" presented to a group of Wilkerson Corp. personnel and industrial distributors, Chicago, Jan. 1958.

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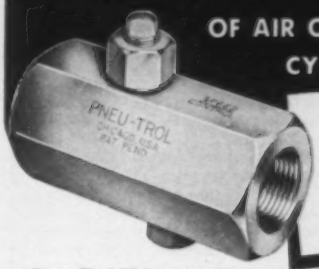

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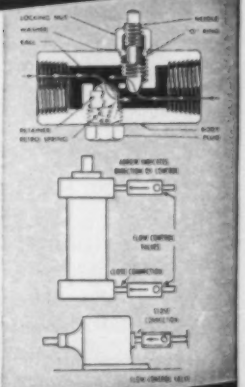
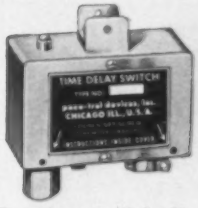
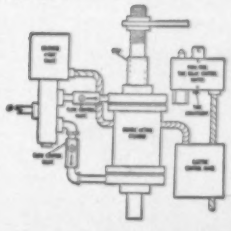


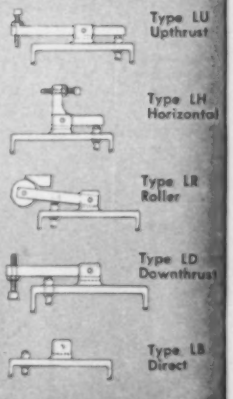


TIME DELAY CONTROL SWITCH FOR PRECISE DELAY OF WORK CYCLE

Provide controlled adjustable time dwell of solenoid operated air or oil supply valves. Range between ¼ and 60 seconds in 20 to 1 ratios. Compact—simple—foolproof—rugged Easily mounted on machine. Available for various types of actuation. Typical diagram below.



For Any Type Actuation Left or Right Hand (Left Hand Shown)



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The part illustrated (approx. ½ actual size), complicated though it may seem, cost one manufacturer only $174.00 for the first 1000 pieces and just $76.00 for each 1000 following. These charges included all blanking, forming and drawing; tools and material.

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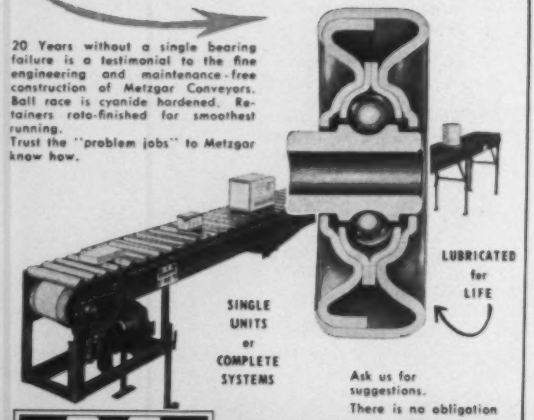

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Circle 712 on Page 141

MACHINE TOOLS IN TRANSITION

By F. KOENIGSBERGER

Reader in Machine Tools and Production Processes
Manchester College of Science and Technology
Manchester, England

AUTOMATIC CONTROL and operation of machine tools is not new and was in use long before the term "automation" had been created. When the power drive was introduced for rotating the work spindles of lathes, drilling, and milling machines, when mechanically-driven feed movements replaced hand operation—in other words, as soon as the power requirements and the operational steadiness and consistency of cutting and feed motions were not left to the manual control of the operator—the first steps of automation had been taken in the field of machine tools.

This did not mean, however, that the services of an operator were no longer required during the actual working of the machine. As the brain which had to control the available power, the operator still had to set, start, and stop the various mechanisms which carried out the required operations.

Early Automation Was Mechanical

Complete automation, i.e., elimination of the need for the presence of an operator, once the machine had been started, was by the introduction of cams and trip dogs in automatic lathes. These produce batches of complete workpieces in a predetermined sequence of different operations with a variety of cutting tools until the material supply is exhausted. The cams or trip dogs operate the feeding and clamping of the stock, the starting, stopping, and reversing of the main spindle (at different speeds, if necessary), the moving into position of the tools required for each operation, and the appropriate slow or fast feed movements of the tool slides.

Apart from the power of the spindle drive, the cutting capacity depends upon the strength of the cams and the lever gears transmitting the feed drive to the tool slides, and these same feed actuating mechanisms may also have to determine the dimensional accuracy with which each operation can be carried out.

The principle, in which driving power and dimensional determination of working strokes are assigned to the same machine elements, has been abandoned in many high precision machine tools such as jig borers. It is also avoided in machines in which trip dogs directly attached to moving tables or slides actuate clutches, thus controlling the movements in accordance with the required position of the *driven*, and not the *driving*, parts. The design of template-controlled following devices may be considered a development of the trip dog idea, with a single-purpose trip dog of infinitely variable profile.

The outstanding feature of the automatic machines previously mentioned is the fact that, once set up, they can carry out singly or repeat over and over again the same sequence of operational movements. They are, in fact, universal machines which, through the provision and setting of stops, tools, fixtures, and specially designed cams, become single purpose ma-

chine tools. Such machines are, for economy if for no other reasons, suitable mainly for the production of large quantities of identical workpieces, the quality of which depends on: 1. The accuracy to which the machine has been manufactured. 2. The degree and consistency of the working accuracy of the machine, i.e., the strength, rigidity, and resistance to mechanical wear of the operating mechanisms and tools. 3. The standard of care and precision applied by the operator when setting up the machine.

The rate of output of these machines depends on: 1. The operational forces which can be handled by the various elements without excessive deformation and wear. 2. The working speeds and power capacity. 3. The time required to control the different operations.

Other Control Means

Recent developments have produced hydraulic, pneumatic, and electrical devices capable of controlling machining operations by translating instructions and results of independent measuring operations into control impulses for adjusting and driving mechanisms. The application of such devices permits the production of complex shapes and profiles which were previously obtainable only by means of hand-made templates or cams. As the expression and transmission of instructions can be achieved by electronic means with greater accuracy, speed, and economy than is possible mechanically or manually in machine tools of orthodox design, a completely fresh approach is necessary.

Versatility of Electronics

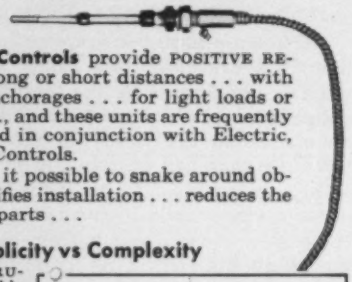
The information necessary for a machining operation is usually supplied by means of a drawing or a planning card. Once this is available and translated into suitable form, electronic devices can be used to initiate or duplicate practically all the work otherwise done by a manual operator. This includes the checking and measuring of movements and the correction, before proceeding to the following operation, of errors which may have occurred. The exception would be unforeseeable complete breakdown; in this case, however, the machine could still be switched off automatically.

Electronic devices can employ the eqivalent of more than two eyes and two hands, and their working speed is not limited by the inertia of moving masses encountered in cam operation. They can work faster, therefore, and can carry out more operations simultaneously than can be achieved by a human operator or by cam control. In addition, high precision measuring devices—optical, pneumatic, or electronic—can be coupled to electronic equipment. The accuracy of measuring and control goes well beyond that hitherto commercially obtainable in automatic machine tools and thus opens the way to manufacture for truly nonselective assembly.

The simultaneous execution of several operations producing a higher total of cutting forces in action

Circle 710 on Page 141

Improved Operation of literally hundreds of mechanical products has been effected with Acco Tru-Lay *flexible* PUSH-PULL Controls

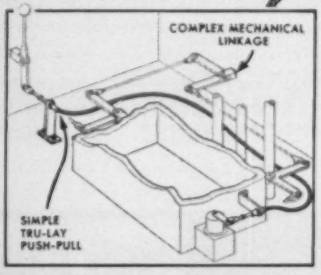


Tru-Lay Push-Pull Controls provide POSITIVE REMOTE-ACTION over long or short distances . . . with fixed or movable anchorages . . . for light loads or loads up to 1,000 lbs., and these units are frequently and successfully used in conjunction with Electric, Hydraulic and Air Controls.

Flexibility makes it possible to snake around obstructions . . . simplifies installation . . . reduces the number of working parts . . .

Simplicity vs Complexity

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Positive Remote-Action and Flexibility, together with Precision and Long Life, explain why TRU-LAY PUSH-PULLS serve designers and users equally well in improving machine operations, whether the application is on such severe service jobs as Bulldozers, Power Shovels and Steel Mill Machinery, or on such light duty work as Photographic Equipment, X-Ray or Business Machines.

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at any time, and the greater operational speeds, result in a higher rate of metal removal and in increased productivity.

Design Considerations

In automating machine tools, it will be appreciated that the following points need special consideration:

1. Operational forces and speeds determine the power requirements of the machine. The higher these power values, the more important become the problems of providing the necessary power and at the same time preventing power wastage which may be caused either by the provision of unnecessarily large power units or by excessive power losses in the machine. Power losses must, therefore, be reduced and power requirements more accurately determined than has been the case in orthodox design practice.

2. Measuring and positioning devices should preferably refer to the cutting edge and the workpiece, and not to the tool slide and the worktable. Otherwise, inaccuracies of slideways, spindles, etc., will escape detection and jeopardize the quality of the workpiece.

However, it may often be found impracticable, if not impossible, to measure directly on the tool or workpiece. In such cases, special precautions must be taken for producing the machine to an accuracy equal or superior to that of the measuring devices or, alternatively, to correct within the required limits the results of unavoidable machine inaccuracies if and when they arise. Tool wear can be measured or the tool can be reground to a specified size at regular intervals. At the same time the machine settings and controls must, of course, be suitably adjusted.

3. Automatic control of the machine tool involves not only transmission of the necessary operating instructions but also a continued comparison with the results obtained. The need for continuously applying corrective action necessitates the use of feedback control devices, i.e., servomechanisms. The purpose of such servomechanisms, which control the various operations, drives, and movements, is to position the various parts in such a manner as to keep the differences between the input information (required position) and the output of the measuring devices (actual position) within prescribed limits. In the case of pure positioning operations as found, for instance, in jig boring machines, the time at which table and saddle reach their required positions is not critical, as long as each part is in position and clamped before the tool starts cutting.

In profiling and similar machines the instantaneous relative positions of the parts, which move while cutting is in progress, must continuously remain correct. This is not a question of just controlling the velocities of the various moving parts; errors in velocity or acceleration as such are only important as far as they affect the relative positions of the moving parts which have to be within the permissible limits at any moment of the operation. The closing of the loop between position measurement and control input must be such as to provide rapid action on the part of the control devices, and it may be necessary to establish limits for the demanded accelerations.

If all conditions during machining operations, such

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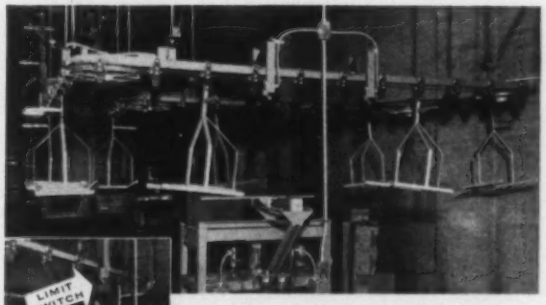

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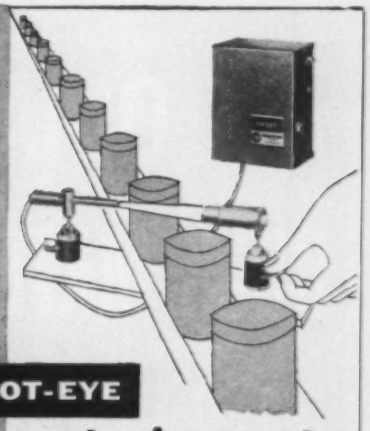

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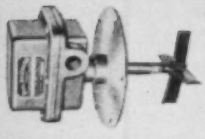

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as the inaccuracy of the machine, the time lag of the drive mechanism, the cutting resistances at any moment, etc., were predictable, accuracy of the final product could still be obtained by proper calibration and corresponding adjustments of the input data to correct the errors. Some of these calibrations would have to be repeated, however, for each particular job. Moreover, practical conditions are likely to change, thus altering the parameters of the calibration.

No relaxation of the stringent conditions in design and manufacture is, therefore, possible, and the nature, order, stiffness, frequency response, and stability margin of the servomechanism must be such as to produce high speed, high precision machining operations.

Team Approach

These problems are, in matter as well as in degree, so different from those hitherto encountered and solved often purely empirically by machine tool designers, that a more fundamental approach is essential, which tackles the job almost from first principles. This applies to methods, layouts, shapes, sizes, and proportions. Calculations, rather than estimates, are often necessary. In order to start such calculations a considerable amount of new information must be made available.

This means a combined operation between scientist and designer, and the use of methods which would have appeared out of place in an industrial workshop not many years ago. This co-operation represents more than just applied research. It is research into design problems, the results of which are immediately tried out on design development, thus closing, as it were, the loop of the exercise.

Work thus undertaken may well be frowned upon at first by both practical designers and academic research workers, the former claiming that their sound experience does not need academic assistance and the latter objecting to research which is not purely looking for absolute truth, but which judges its value from the point of view of its immediate applicability to the solutions of practical industrial problems. These opinions may, of course, be reversed if such work will provide the designer with material unobtainable from his experience and obtained by means of a sound scientific approach to and execution of the work.

In order to gain the full benefit from work of this kind it is essential to tackle it simultaneously from the mechanical and the electrical engineering angle. At present it is often found that a company of electronic engineers supplies standard equipment to be used in conjunction with more or less standard machine tools manufactured by another company. Combined simultaneous efforts of a team consisting of mechanical engineers experienced in machine tool development, and electrical engineers specializing in the development of electronic equipment, will result not only in each side appreciating and trying to satisfy the needs of the other, but also in a cross-fertilization of ideas which will be beneficial to all concerned.

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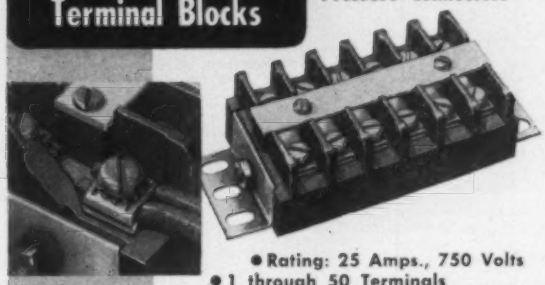

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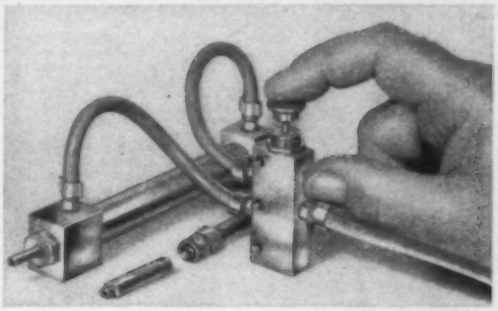

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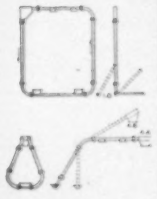

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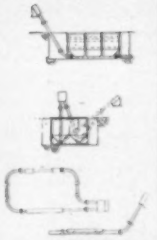

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AUTOMATION problem forum

Readers with problems concerning systems, equipment or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Solution suggestions should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

Case 1620-P
Selective Conveyor Control

. . . We are looking for the following: Dial selector control unit for overhead conveyor systems. This control would automatically operate the conveyor and bring parts to a designated point by the shortest route. The control unit to be so designed to allow for a different number of selections on the conveyor itself, such as a 200-unit selector for one system or as high as 1,000-unit selector for a larger system. As we have not been able to perfect a unit so described, we would appreciate assistance in this matter and hope that through your magazine we will find the answer we need . . .

Conveyor Manufacturer

• • •

Case 1618-P
Molding Wax Discs

. . . We manufacture wax (paraffin) discs for the cotton yarn trade. At present we are casting these discs in molds, pouring the liquid paraffin by hand. We would like to apply automatic methods to our production line. Production should be in the neighborhood of 1000 gross per month. Melting point is variable from 133F to 143F. Thickness of discs varies from 0.375 to 0.875 inch depending upon requirements. OD is 1.625 inch, with a hole of 0.5625 inch in the center. Tolerance should be held to plus or minus 0.0156 inch. All surfaces should be smooth and free of any cracks, and no air bubbles within the discs. Any help would be greatly appreciated . . .

President

• • •

Case 1602-P
Lumber Handling

. . . We wish to transfer lumber from a cross conveyor to a final conveyor. The boards travel on the cross conveyor with the long axis of each board perpendicular to the line of motion. The boards are to be turned 90 degrees and lowered 12 feet onto a final conveyor running parallel to the cross conveyor but in the opposite direction. The lumber is metered to the cross conveyor and varies in length from 6 to 20 feet, in width from 4 to 14 inches, in thickness from 1 to 4 inches, with some 80 per cent of the production being boards 1 inch by 8 inches by 16 feet. Whatever device is used to lower the lumber 12 feet and rotate it 90 degrees must be capable of handling 2000 or more boards per hour. The boards should follow one another on the final conveyor, however an occasional overlap would not be serious. Either face may be up on the final conveyor. Either end of the board may be forward on the final conveyor. Any suggestions you may have for approaching this problem would be greatly appreciated . . .

Production Manager

• • •

Suggestions for 1593-P (Aug 1958)
Cutoff and Chamfer

. . . We are enclosing a circular describing our automatic machines. You will note they are lathe type machines which hold the stock in a collet and rotate it while cutting, and thus the stock must be in straight lengths. There is no problem connected with cutting 5/16 and ⅜ inch. However, in cutting ¼-inch copper, we have found where the copper is too soft it will have a tendency to break the tubing off at the collet. We note that this is ¼-hard copper tubing and will not present this problem when using a 1/16-inch wide cutoff blade . . .

B. H. Walker
Modern Machine Tool Co.

•

. . . We are enclosing our catalog. The No. 1 Machine falls into the range of tubing your reader would be cutting. We would be interested in helping him further and would suggest that he forward samples. We will cut them and return same with actual cutoff times . . .

H. O. Barten
Continental Machine Co.

•

. . . We would be pleased to be of assistance to the reader. Attached you will find literature on our equipment which is available for immediate shipment . . .

E. W. Metcalf
Collins Machinery Corp

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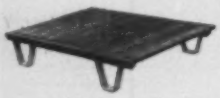

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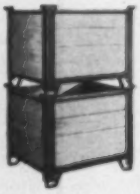

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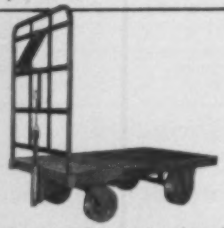

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Circle 725 on Page 141

new catalogs..... latest literature

Vibrating Conveyors

Ajax Flexible Coupling Co. Inc., Westfield, N. Y.—16 *page booklet*—Data on vibrating conveyors for bulk materials are contained in Catalog 66. Cutaway photos show the design and construction of the conveyors. Flow charts display the different processing operations which can take place while the material is being conveyed. Also included are notes on vibrating screens for scalping, separating, and sizing; and vibrating packers for settling bulk materials in cartons, bags, and drums.

Circle 468 on Page 141

Turret Lathe Control

De Silvey Corp., 200 Pennsylvania Ave., East Aurora, N. Y.—8 *page bulletin*—Control unit which automatically performs all turret lathe functions is described. Operation of the Director, which can be automatic, semiautomatic, or manual, is discussed. Components of the unit are explained and illustrated. Company services are also mentioned.

Circle 469 on Page 141

Spectrometers

Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.—Two types of electronic instruments designed to continuously measure the amount of the various constituents in a process stream are described in Bulletin 1824C. Operation of the main elements in each type, the Diatron and the Cycloid tube, is explained and sketches show the position of the components. Illustrative examples of different applications are given and notes are also included on the accessories which are available.

Circle 470 on Page 141

Helical Gear Drives

Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.—6 *page pamphlet*—Helical gear drives in double, triple, and quadruple reduction are described in Folder 2651-A. A cutaway view shows construction features. Data such as horsepower ratings, dimensions, and mounting styles are given.

Circle 471 on Page 141

Magnet Drum Separator

Stearns Magnetic Products, 635 S. 28th St., Milwaukee 46, Wis.—8 *page bulletin*—A permanent magnet drum separator, which is designed to automatically and continuously remove tramp iron, is the subject of Bulletin 1051. Composition of the ceramic magnet material is explained, and a sketch illustrates the principle of operation. Separator is available in three basic models with enclosures to match various spouting systems in the process industry. Charts list the specifications and dimensions of the three models.

Circle 472 on Page 141

Salt Bath Furnaces

Ajax Electric Co., 994 Frankford Ave., Philadelphia 23, Pa.—76 *page catalog*—Line of heat treating equipment is described in Catalog 117. The types of furnaces described include metal pot furnaces, over-the-top electrode furnaces, and ceramic tile pot furnaces. Construction of the units and mechanisms used are explained. Charts are given which list austempering and martempering curves, show penetration times for carburizing, and heating rates for typical steels. Details on various types of applications are discussed.

Circle 473 on Page 141

Industrial Switches

Micro Switch, Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.—32 *page catalog*—Data on line of basic switches for industrial applications are contained in Catalog 62c. Contents of the switches and electrical ratings are explained, and the different contact arrangements and terminal designs are described. Accessories, such as switch actuators and terminal enclosures, are also covered. Also included are notes on installing the switches.

Circle 474 on Page 141

Resistance Welding

Sciaky Bros. Inc., 4915 W. 67th St., Chicago, Ill.—12 *page booklet*—Volume 5, No. 3, entitled "Resistance Welding at Work," describes resistance welding case histories. Among the applications covered is one for adapting standard welders for automatic production and one which used multiple electrode welding presses for automatic production welding in the automotive industry.

Circle 475 on Page 141

Hydraulic Press Brakes

Cleveland Crane & Engineering Co., Wickliffe, Ohio—8 *page bulletin*—Data on hydraulic press brakes are contained in Catalog 2024A. The various components in the press brake are described and illustrated, and features such as constant power stroke, adjustable stroke length, and tonnage adjustment are explained. Notes on hydraulic shears are also given.

Circle 476 on Page 141

Adjustable Speed Drives

Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio—16 *page booklet*—V•S Drives, which provide precise, adjustable machine speeds from in-plant ac circuits, are described in Bulletin D-2506. Functions of the drive components, which include regulators, exciters, motor-generator sets, and the operator's panel, are explained. Specifications and dimensions are listed and illustrations show the different accessories.

Circle 477 on Page 141

Rotary Pumps

Warren Pumps Inc., Warren, Mass.—8 *page bulletin*—Rotary units for pumping viscous liquids are covered in Bulletin 50. Descriptions of two types of units are given, and cutaway photos display the hydraulic and mechanical design. Also included is a selection chart for pumps for pumping liquids with viscosities of 300 to 1500 SSU.

Circle 478 on Page 141

Cut-Off Machines

Modern Machine Tool Co., 2005 Losey St., Jackson, Mich.—4 *page pamphlet*—Data are given on machines for high speed cutting off of tubing, pipe, and bar stock. Production rates, capacities, features, and optional equipment are listed. Also described and illustrated is equipment which can be used in-line with the cut-off machine. This equipment includes an automatic bar feeder and a hot spinning machine which closes and seals ends of tubing.

Circle 479 on Page 141

Induction Heating Equipment

Magnethermic Corp., 3990 Simon Rd., Youngstown 7, Ohio—12 *page booklet*—High frequency induction heating equipment for heat treating, annealing, brazing, forging, and shrink fitting is outlined in Bulletin HF-58-6. Data on heat stations and generator control units are given. Vertical motor generator sets are also described, their construction details and protective devices noted.

Circle 480 on Page 141

new catalogs..... latest literature

Coil Winding Equipment

Geo. Stevens Mfg. Co. Inc., Pulaski Rd. at Peterson, Chicago 46, Ill.—62 *page catalog*—Data on coil winding machines, wire scrapers, and wire insulating equipment are given in Catalog 59. Types of winders include hand fed winders, armature winders, transformer winders, and bobbin winders. Accessories such as tensions, counters, tailstocks, cams, and gears are also described. Included too, are winding formulas for various machines.

Circle 481 on Page 141

Automatic Controls

Automatic Controls Div., Barber-Colman Co., 1300 *Rock St., Rockford, Ill.*—52 *page catalog*—Line of controls for heating, ventilating, and air conditioning systems is covered in Catalog 26. Data are given on electric thermostats, pressure controls, humidistats, motor-operated valves, temperature regulators, motor operators, unit ventilator controls, hot water controls, electronic controls, and control centers. Accessories are also described and definitions of various electrical terms are given.

Circle 482 on Page 141

Pusher Furnaces

C. I. Hayes Inc., 808 *Wellington Ave., Cranston* 10, *R. I.*—4 *page pamphlet*—Pusher type furnaces for progressive batch heat treatment of materials requiring temperatures up to 2400 F are described. Data are given for two styles. Type BA is used for bright treatment of stainless steels, sintering of powder metal parts, and copper brazing. Type BA-M is a packaged furnace which is equipped with a panel mounted electrical control system.

Circle 483 on Page 141

Magnetic Equipment

Eriez Mfg. Co., 70D *Magnet Dr., Erie, Pa.*—48 *page catalog*—Permanent, nonelectric magnetic equipment is described, which is suitable in the chemical, plastic, food processing, paper, and metal working industries. Units described include magnetic separators which are used to guard against tramp iron damage; magnetic automation units for conveying, controlling, or elevating metal parts; and magnetic vibratory feeders.

Circle 484 on Page 141

Facilities Booklet

Fischer & Porter Co., 792 *Jacksonville Rd., Hatboro, Pa.*—24 *page booklet*—Company's facilities for manufacturing flowmeters, process instrumentation, data reduction and automation equipment, chlorination equipment, and glass products, are outlined. Charts show the growth in sales during 20-year operation. Plans for the future are discussed.

Circle 485 on Page 141

Product Marking

Markem Machine Co., Keene, N. H.—8 *page bulletin*—Data are given for marking components, parts, and products in the electrical and electronic industries. Among the machines described are cylindrical object printers for relays, resistors, vacuum tubes, and coil forms; and flat surface printers for panels, filters, cases, and boxes. Also mentioned is a special purpose machine for automatic marking on the top and around the periphery of wire lead transistors.

Circle 486 on Page 141

Steel Belt Conveyors

Sandvik Steel Belt Conveyors, Div., Sandvik Steel Inc., 1702 *Nevins Rd., Fair Lawn, N. J.*—8 *page bulletin*—Bulletin 200 is a guide for designing steel belt conveyors for applications such as conveying materials through ovens and cooling tunnels, in handling foods and chemicals, and in handling metal parts. Engineering aids such as nomographs, tables, line drawings, and graphs are given. Also included are data on the properties of both carbon and stainless steel belts, methods of support, end joints, inclines, and belt tension.

Circle 487 on Page 141

Digital Control Computer

Thompson-Ramo-Woolridge Products Co., P.O. Box 45067, *Airport Station, Los Angeles* 45, *Calif.*—4 *page pamphlet*—Model RW-300, a digital control computer for automatic on-line control of industrial processes is described. Operating characteristics and specifications are listed. Also discussed are process control, data logging, pilot plant, and test facility applications for computer control systems.

Circle 488 on Page 141

Metal Sheet Feeder

Dexter Co., Div., Miehle-Goss-Dexter Inc., Pearl River, N. Y.—6 *page pamphlet*—Model TF-6, an automatic metal sheet feeder with a capacity up to 6000 lb and speeds up to 85 sheets per minute, is described. The continuous reloading operation is explained and production features noted. Electrical specifications and operating data are given.

Circle 489 on Page 141

Thyratron Grid Control

VecTrol Engineering Inc., P. O. Box 1089, *Stamford, Conn.*—4 *page pamphlet*—Packaged control, which is applicable to electronic power supply equipment, electronic motor drives, and electronic automation controls, is described in Bulletin 101-L. Charts show performance curves and diagrams show electrical circuit details.

Circle 490 on Page 141

Eccentric Geared Presses

Niagara Machine & Tool Works, 683 *Northland Ave., Buffalo* 11, *N. Y.*—44 *page catalog*—Data are given in Bulletin 66A on straight side, single action, eccentric geared presses for large, heavy tonnage drawing, punching, and blanking work. Construction of the crankless eccentric drive and pneumatic friction clutch is explained. A schematic drawing illustrates the automatic circulating oil system. Notes on other automatic devices and controls on the presses are given. Also mentioned are automatic loading, unloading, and transfer equipment.

Circle 491 on Page 141

Precision Potentiometers

Electromath Corp., 42-14 *Greenpoint Ave., Long Island City* 4, *N. Y.*—8 *data sheets*—Collection of data sheets describes various standard potentiometers. Some of the styles include 10-turn, 3-turn, single-turn, and dual 10-turn potentiometers. Features and applications are noted and both electrical and mechanical specifications are listed.

Circle 492 on Page 141

Flow Regulators

Waterman Engineering Co., 725 *Custer Ave., Evanston, Ill.*—16 *page booklet*—Line of flow regulators for hydraulic power systems is outlined in Catalog 1000. The types of units in the line include fixed-flow regulators, limited-range adjustable flow regulators, and full-range adjustable flow regulators. Most of the regulators are rated at 3000 psi. Also included is an orifice-flow chart and suggestions for selecting the proper regulator.

Circle 493 on Page 141

Boring & Milling Machine

Marac Machinery Corp., 45 *S. Broadway, Yonkers, N. Y.*—12 *page booklet*—Model KBF2, a high precision boring and milling machine, which provides numerical control as standard equipment, is described. Control of machine operations is by two methods—numerical dials or punched cards. Both methods are explained, as is the operation of the automatic gaging system. Also included are illustrations of the different work tables available for the machines.

Circle 494 on Page 141

Rotary Blowers & Pumps

Sutorbilt Corp., 2966 *E. Victoria St., Compton, Calif.*—20 *page booklet*—Line of rotary positive blowers, gas pumps, and vacuum pumps is outlined in Bul-

letin S65C. The line is designed to handle volumes of air or gas from 1000 up to 20,000 cfm, and pressures and vacuums up to 10 psig single stage. Operating principles are explained and cutaway drawings show the construction of the blowers and pumps.

Circle 495 on Page 141

Explosive Valves & Latch Pins

Explosive Products Div., Conax Corp., 2300 Walden Ave., Buffalo 25, N. Y.—16 page booklet—Line of explosive valves, latch pins, actuators, and thermocouples and pressure sealing assemblies, is outlined in Catalog 5808-XV. Operation of the valves and latch pins is explained and construction of the units is shown by sketches. Also included is a chart showing response time for the thermocouple assemblies.

Circle 496 on Page 141

Pointing Machines

Economy Engineering Co., Willoughby, Ohio—4 bulletins—Automatic, double end automatic, and semiautomatic pointing machines for bolts, screws, studs and rods are described in bulletins. Applications, specifications, and construction features are noted. Principle of operation of each machine is also explained.

Circle 497 on Page 141

Carbide Throwaway Inserts

Pratt & Whitney Co. Inc., Charter Oak Blvd., West Hartford 1, Conn.—4 page pamphlet—Data and prices are given in Bulletin 620 on line of carbide throwaway inserts in both square and triangular shapes to fit standard single point holders. Units can be used for all turning and boring operations. Significant economies can be realized in that costly tool grinding is eliminated since the inserts are cheaper to replace than to regrind.

Circle 498 on Page 141

Industrial Television

Electronics Div., Diamond Power Specialty Corp., Lancaster, Ohio—12 page booklet—Industrial television systems—used for visual observations of an operation or function which is beyond the normal line of sight—are described in Bulletin 2239. Various equipment and accessories are covered, and suggestions are noted for selecting the proper system for an application. Case histories for different operations are also reported.

Circle 499 on Page 141

High Frequency Equipment

Louis Allis Co., 427 E. Stewart St., Milwaukee 1, Wis.—12 page booklet—High frequency equipment, which is capable of increasing the output of high production machinery, is covered in Bulletin 2250. Two types of power supplies are described—induction frequency converters and motor-alternators. The converters are suitable for use where 80

INDEX OF EQUIPMENT BY ITEM NUMBERS

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to 400 cps are needed, and the alternators are adaptable for operations requiring 400 to 3000 cps. The differences in these two sources are discussed and their capabilities for constant and adjustable speed are outlined.

Circle 500 on Page 141

Photoelectric Controls

Photoswitch Div., Electronics Corp. of America, One Memorial Drive, Cambridge, Mass.—24 *page catalog*—Photoelectric equipment is described in Bulletin PA561 for controlling functions such as counting, sorting, inspecting, timing, detecting, indexing, and measuring. Regular, miniature, and subminiature receivers and light sources are covered. Accessories and housings are also noted. Selection charts list characteristics and operating range of units.

Circle 501 on Page 141

Packaged Amplifier

George A. Philbrick Researches Inc., 285 Columbus Ave., Boston 16, Mass.—16 *page booklet*—Data are given on Model UPA-2, a utility packaged amplifier suitable for use in computer type operations. Booklet describes how the unit combines a new level of circuit flexibility with the reliability of computer grade, printed circuit operational amplifiers. Also listed are mechanical and performance characteristics.

Circle 502 on Page 141

Totalizing Flow Meter

Builders-Providence Inc., Div., B-I-F Industries Inc., Providence 1, R. I.—16 *page booklet*—A totalizing flow meter which is suitable for steam, air, or gas is described in Bulletin 400-J10A. Operating principle, installation methods, capacities, calibration, and pressure drop are explained. Schematic drawings of the meter and capacity tables are given.

Circle 503 on Page 141

Voltage Regulators

Voltage Regulator Product Section, General Electric Co., 100 Woodlawn Ave., Pittsfield, Mass.—24 *page catalog*—Line of voltage regulators is described in Bulletin GEC 1450. Industrial units are designed to accurately hold a constant load voltage when supplied from a fluctuating supply voltage. Principle of operation, features, and applications are explained. Also included are prices, connection diagrams, and outline drawings.

Circle 504 on Page 141

Rotary Surface Grinder

Mattison Machine Works, Rockford, Ill.—2 *bulletins*—Model 24, a rotary surface grinder with automatic cycling is described in both folders. Construction of the different components in the machine are discussed and illustrative examples of various applications are given. The sequence of operation of the automatic cycling is explained, as is the control board and adjusting mechanism.

Circle 505 on Page 141

Vertical Motor-Generator

Safety Industries Inc., P. O. Box 904, New Haven, Conn.—6 *page pamphlet*—High frequency vertical motor-generator line is the subject of Bulletin SK-4897. The induction-type motor-generator sets are available with ratings from 50 kw up to 350 kw at 1000 cycles. Construction and assembly are explained and suggestions for proper maintenance given.

Circle 506 on Page 141

Clutches/Brakes

Dynamatic Div., Eaton Mfg. Co., Kenosha, Wis.—8 *page bulletin*—Stationary-field clutches and replaceable-face brakes designated Dyna-Torq, are discussed in Bulletin RSF-1. Design of flange-mounted brakes and bearing and flange-mounted clutches is described. Features such as resin-bonded field magnets, one-piece rotors, and splined hub mounting are explained. Notes are also given on a plug-in type control which provides dc power for actuation of the clutches and brakes.

Circle 507 on Page 141

Automatic Press Feeds

Perkins Machine Co., Warren, Mass.—6 *page pamphlet*—Equipment is described which automatically feeds various kinds of material to presses. Types of feeding units covered are single roll feeds, double roll feeds, front to back feeds, and dial feeds. Illustrations show features, and advantages of each type feeder are listed.

Circle 508 on Page 141

Solderless Terminals

Vaco Products Co., 317 E. Ontario St., Chicago 11, Ill.—12 *page booklet*—Data are contained in Catalog T-70 on line of quick-connect terminals and adapters, ring tongue, spade tongue, flag, and hook type terminals, butt connectors, and insulation tubing. Notes are given on service kits for various applications. Also described and illustrated is a bolt cutter and crimping tool which shears bolts or machine screws, cuts wire, and crimps solderless terminals.

Circle 509 on Page 141

Thread Rolling Attachments

Landis Machine Co., Waynesboro, Pa.—14 *page booklet*—Five sizes of thread rolling attachments for automatic screw machines and turret lathes are described in Bulletin G-96-2. Features and construction of the various components in the unit are explained, aided by photos. Sketches are included which show the optional equipment that is available to produce different types of threads.

Circle 510 on Page 141

Liquid or Bin Level Controls

Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus 12, Ohio—8 *page bulletin*—Two units for measuring and controlling liquid level in tanks or the level of solids in bins—a level detector controller and a continuous level measurement system—are described in Bulletin NI-658. Operation of both systems is explained and notes on the components in them are given. Sketches show different arrangements of the systems.

Circle 511 on Page 141

Automatic Setscrew Driver

Standard Pressed Steel Co., Jenkintown, Pa.—4 *page pamphlet*—Setscrew driving device is described, which can automatically feed, insert, and tighten socket setscrews ranging in diameter from #4 to ⅜-inch, in lengths up to ¾-inch. Machine can be used in an automated production line or as an attachment for a single unit. Illustrations of the feed and drive mechanisms are given and diagrams show three modes of operation.

Circle 512 on Page 141

Proximity Control

Electronics Div., Trimount Instrument Co., 3119 W. Lake St., Chicago 12, Ill.—4 *page pamphlet*—Instrument is described which is suitable for level or interface control of nonconductive liquids, semi-solids, and free flowing granular materials. Unit can also be used for high and low level alarm, and limit switching. Operation of the control is discussed and the three types of probes—vertical, horizontal, and flush—are explained. Sketches show the different applications.

Circle 513 on Page 141

Calibration Standard

Taylor Instrument Cos., 95 Ames St., Rochester 1, N. Y.—4 *page pamphlet*—Portable instrument is described which checks and calibrates amplifiers, servo controls, potentiometer transmitters, and similar equipment. Operation of the instrument is reported and an actual size photo of the main panel is given. Data are given on the circuit and components such as the battery, galvanometer, slidewire, and resistors.

Circle 514 on Page 141

Roller Chain Drives

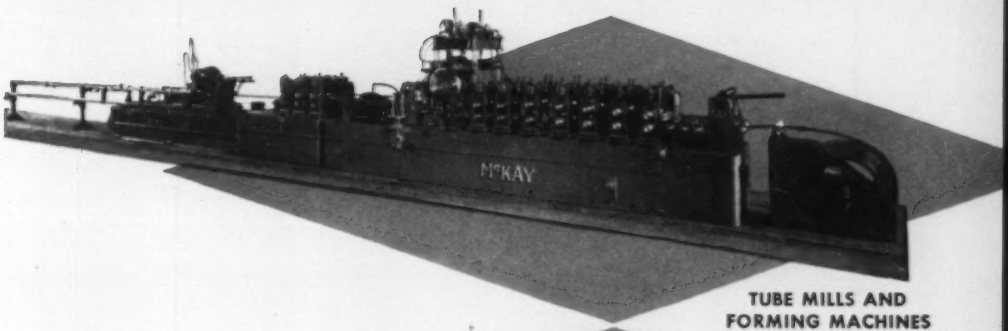
Maurey Mfg. Corp., 2915 S. Wabash Ave., Chicago 16, Ill.—8 *page bulletin*—Data are contained in Catalog D-58 on line of roller chain drives. Units described include bushed and plate type sprockets, and single strand and double strand roller chains. Charts list prices, strengths, and weights.

Circle 515 on Page 141

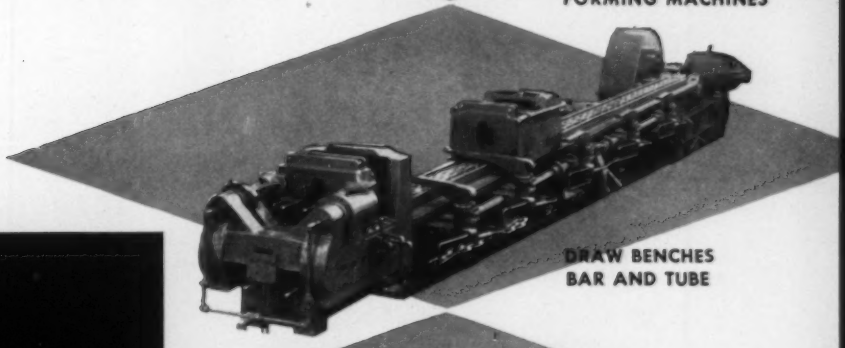
Plastics Molding Machine

Hydraulic Press Mfg. Co., Div., Koehring Co., Mount Gilead, Ohio — 6 *page pamphlet*—Model 450-P-80, an 80 ounce capacity plastics injection molding machine, is the subject of Bulletin 58P80. The preplasticizing and injection assemblies are illustrated by a drawing and the sequence of operation is explained. Specifications for the different mechanisms are listed.

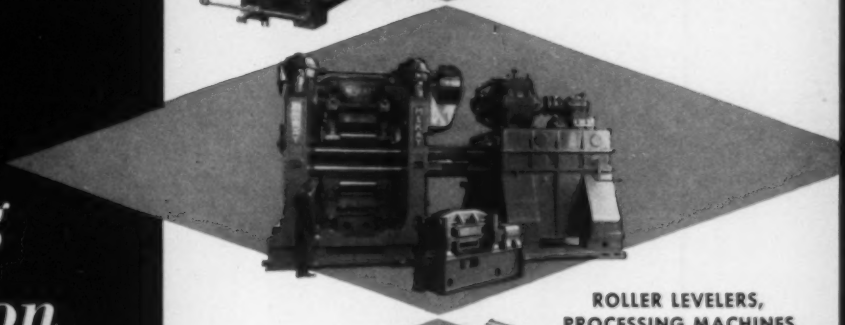
Circle 516 on Page 141



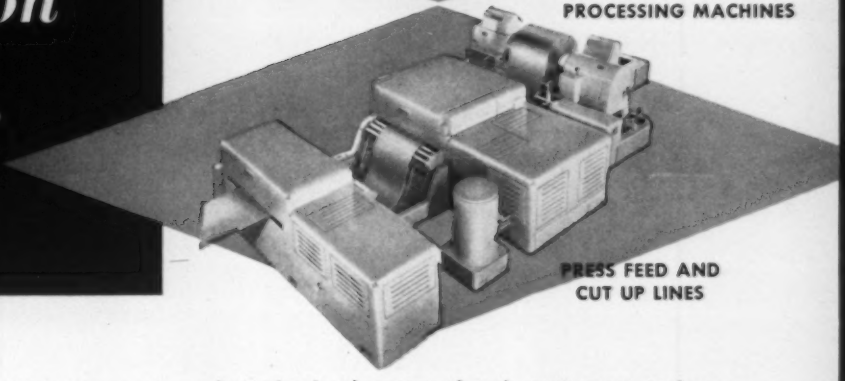
TUBE MILLS AND
FORMING MACHINES



DRAW BENCHES
BAR AND TUBE



ROLLER LEVELERS,
PROCESSING MACHINES



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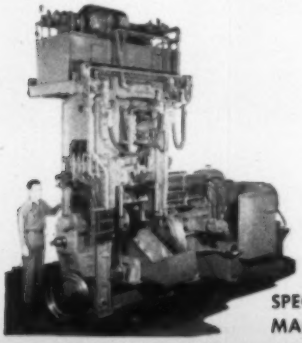
Circle 652 on Page 141



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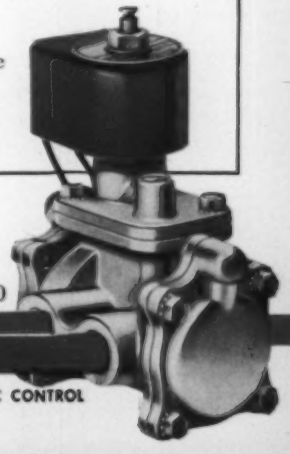

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